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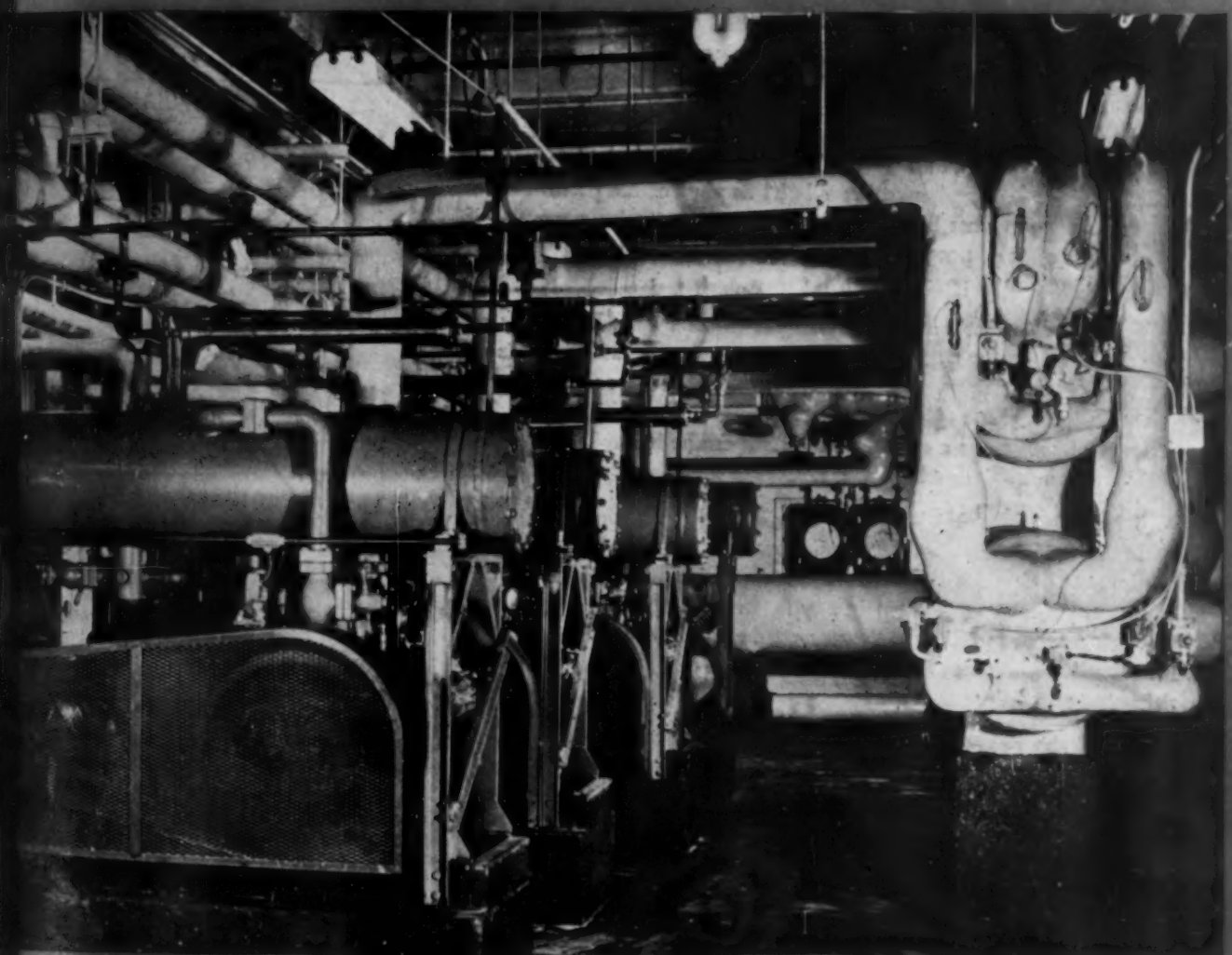
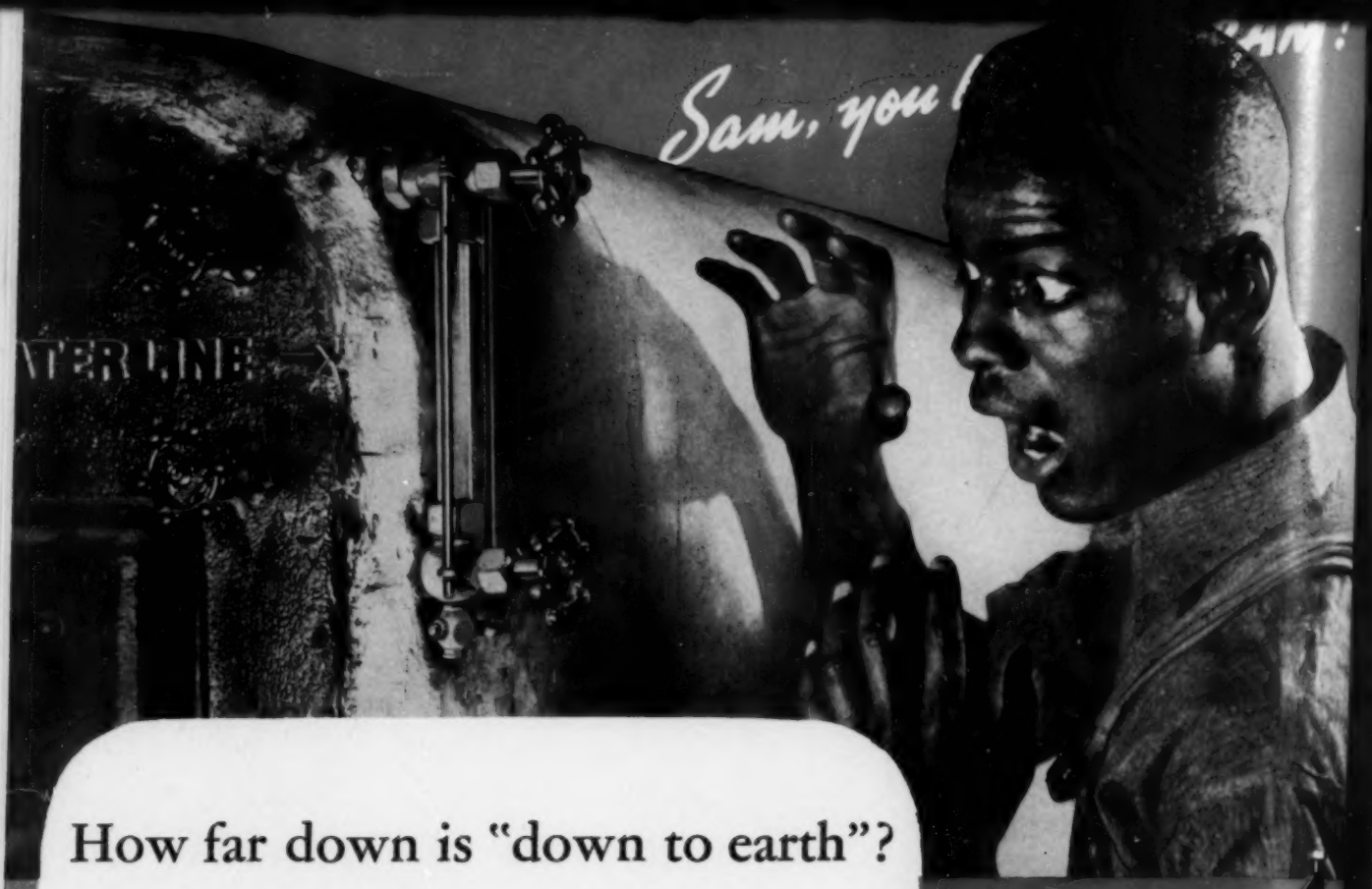


*Refrigeration machines and piping for maintaining low temperatures during an industrial process*

CONTENTS . . PAGE 67

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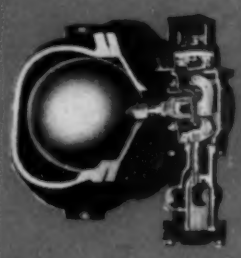

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# CONTENTS THIS MONTH

Vol. 18 **JUNE 1946** No. 6

The Editor's Pages (news notes and comment) ..... 63

Methods of Making Piping Flexibility Analyses, by Sabin Crocker and Arthur McCutchan ..... 69

Contractors Hold Big Meeting (HPACCNA Convention) ..... 74

Engineer, Physiologist & Psychologist Are Involved in Heating, Conditioning, by B. von Haller Gilmer ..... 77

Should We Use Unit Heaters or Radiant Heating in Factories?, by M. J. Druse ..... 80

Using the Reverse Cycle for Heating, Conditioning, by G. E. Clancy ..... 82

"Open for Discussion"—How Should Pipe Wall Thickness Be Figured?, by Otis W. Page ..... 86

Cleaning and Blowing Down HRT Type Boiler, by John G. Cronin ..... 88

Airplane Heating and Ventilating Involves Many Special Problems, by Maurice Martin ..... 89

Question of the Month—Should We Use Units for Heating a Greenhouse? ..... 94

Sam Lewis' Page—The Air We Live In ..... 98

Data Sheet—Pipe Specifications ..... 101

Equipment Developments ..... 149

New Books & Reports ..... 164

Meetings & Conventions ..... 166

Recent Trade Literature ..... 170

Index to Advertisers ..... 184

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## Journal Section of the American Society of Heating and Ventilating Engineers

Heat Losses Through Wetted Walls, by E. C. Willey ..... 103

Periodic Heat Flow—Composite Walls or Roofs, by C. O. Mackey and L. T. Wright, Jr. ..... 107

The Effect of Turbulence Promoters on Heat Transfer Coefficients for Water Flowing in Horizontal Tubes, by Lawrence G. Seigel ..... 111

Summary of Local Chapter Meetings ..... 116

Candidates for Membership ..... 120

Candidates Elected ..... 121

Officers, Council, and Committees ..... 123

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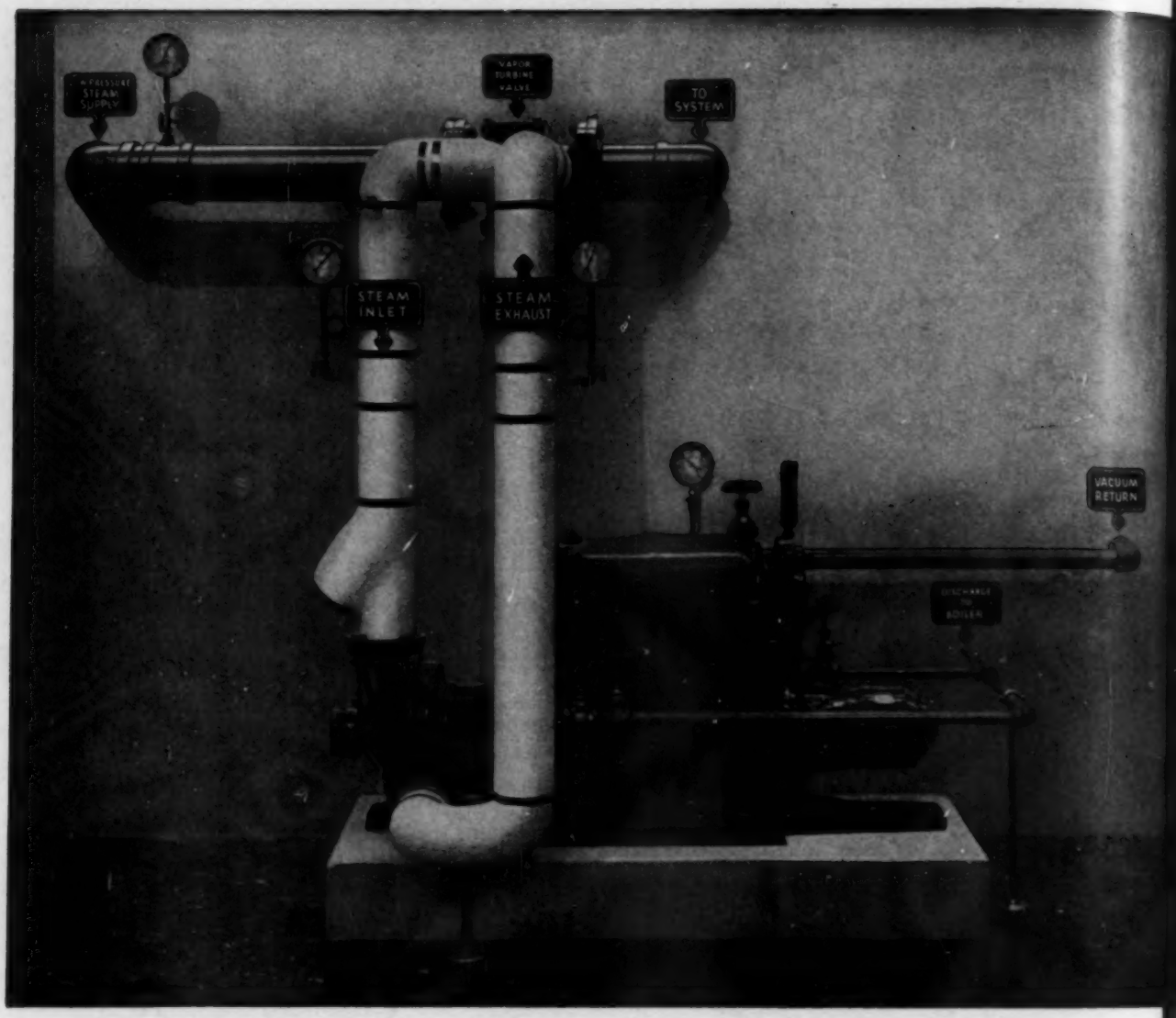


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VALUABLE REVIEW

# Methods of Making PIPING FLEXIBILITY Analyses

By Sabin Crocker, Senior Engineer-Mechanical, The Detroit Edison Co., and Arthur McCutchan, Engineer, Engineering Div., Detroit Edison Co.

**MANY WAYS of analyzing the flexibility of piping systems have been developed, and there has been a great amount of material on the subject of piping flexibility published (the valuable bibliography given with this article lists over 60 references). The numerous methods available are confusing unless one has made a thorough study of all of them over a period of years; in fact, one piping designer recently suggested to the editor that some authority should "standardize" one method and require all engineers to use it. . . . In order to assist those who must analyze piping flexibility in order to design and install piping systems, we embark this month on a rather unusual editorial project (which we hope will be a success). This article reviews briefly methods of flexibility analysis, and we hope to follow it up with a series of brief articles in which the advocates of the various methods will describe their respective merits. Each author will be asked to use his method to work out a typical problem, so that the reader may judge for himself the suitability of the different calculation procedures in his own piping work.**

THIS article is intended as an introduction to a proposed series in which the merits of various current methods of flexibility analysis will be described by their respective advocates. Because of the extent of the published material on piping flexibility it is not intended to present in detail the various underlying theories and derivations. Each author will be asked to give a brief description of the application of his preferred method to one or more typical problems. The reader may then form his own opinion as to the suitability of a particular method for his own work.

In order to afford direct comparisons it has been suggested that each author present solutions for the Z-bend one plane layout shown on Fig. 1 and for the three dimensional problem illustrated on Fig. 2. The three-dimensional problem is the one described by Hovgaard[18] in his 1935 paper and again in 1937. The reason for selecting the latter is the fact that this particular problem has been solved by so many different methods. While welding fittings and plain bends are shown in Figs. 1 and 2, the effect of substituting creased or corrugated bends and corrugated tangents on the resulting forces, bending moments, and stresses will—it is planned—be developed in one of the articles.

The analysis of piping systems in which all the pipe fillers and bends lie in one plane between two anchor points (see Fig. 1) can be carried out by a number of methods with rather closely equivalent results. The "exactness" of the results depends almost entirely on the extent to which the actual disposition of the line is modified to facilitate solution, or the bends and elbows are considered to be replaced by straight pipe.

The question of what method of analysis to use depends primarily on the complexity of the problem and individual preference of the designer. Familiarity with several methods often will be found of value in sizing up a particular problem and in recognizing where simplified chart solutions or tables can be used in place of detailed calculations.

The determination of stresses and reactions in three-dimensional piping systems is considerably more involved than the solution of one-plane problems. The more exact methods which take into account flattening of the circular cross section of the curved portions become increasingly difficult as the number of elements increases.

Piping flexibility problems have been simplified by breaking the line into its component parts—such as straight lengths, quarter bends, etc. Various methods of combining the effects of the forces and moments transposed from the anchor points to the component parts have been developed. The grapho-analytical method[10] developed by Crocker and McCutchan facilitates the combination of deflections due to bending within each part with those due to rotation of the elements between each part and the anchored end of the section of piping under study. Solution of the algebraic method employed by Hovgaard[18] and others can be facilitated through the use of standardized computation forms[20] whereby the labor of numerical computation is considerably reduced. Where a square-corner approximation is deemed sufficiently accurate, either algebraic or grapho-analytical methods reduce to a consideration of the effect of transverse forces and bending and torsion on simple cantilever beams. With the grapho-analytical method the area-moment diagrams for

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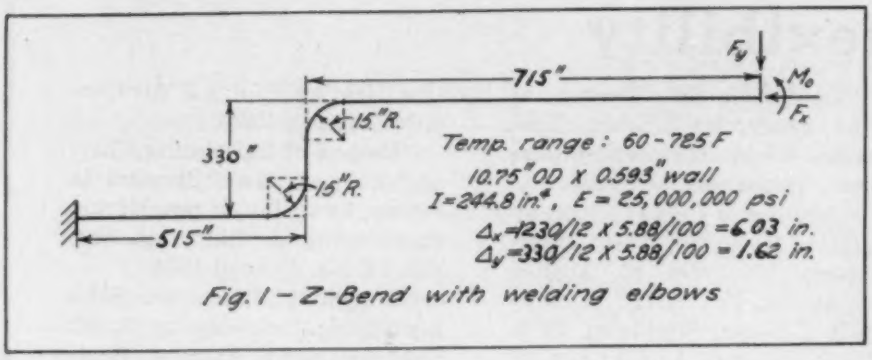



Fig. 1 – Z-Bend with welding elbows

these loadings are triangles and rectangles, so areas and distances are easily computed.

It is hoped that suitable charts or tables can be presented in connection with one of the articles of this series which will enable a better appraisal to be made of the corrections which should be applied to square-corner solutions, particularly where welding elbows are used.

While all methods of computation are greatly simplified by assuming that arcs are replaced by square corners, some methods are confined to the solution of square-corner problems. Where pipe bends having a center-line radius of four to six pipe diameters are involved and the proportion of bends to straight pipe is not too great, square-corner approximations can be used with good success. Where welding elbows with a center-line radius of 1½ pipe diameters are used, the forces and moments obtained from square-corner approximations may be more than 50 per cent greater in certain configurations than obtained by taking the arcs into account. In the more usual combinations of pipe and welding elbows, the forces and moments found from square-corner solutions are about 25 per cent greater than for solutions which take the arcs into account.

In many cases the results obtained by square-corner approximations are fully adequate for the purpose, but a more economical disposition of pipe may be possible where arcs are considered as such. In any case it is believed that the stress concentrations existing in curved pipe should be taken into account.

It should be recognized that most so-called "exact" solutions neglect some of the minor rotations which result from sideways loading of curved pipe and that few of them recognize the effect of flattening of the cross section at 45 deg to the plane of the bend, which occurs as observed by Vigness.[26]

It is difficult to assess properly the effect of neglecting the minor rotations and the extra flexibility caused by distortion of the cross-section of curved pipe under sideways loading. Hovgaard (in his 1937 ASME paper[18]) investigated the effect of omitting the secondary terms in a three-dimensional layout consisting of two quarter bends with and without tangents of different lengths. Fig. 2 represents an intermediate condition in this comparison. His overall conclusion was that "on the whole it appears permissible to omit all the secondary terms, but it may be advisable in certain cases to make a rough calculation of the errors involved." The above conclusion was reached before the discovery by Vigness[26] of the effect of flattening of the cross section of bends at 45 deg to the plane of the bend which occurs under sideways loading. The secondary rotations in the case of a welding elbow when Vigness' corrections are taken into account are found to be ⅓ of the primary rotation rather than 1/12, as had previously been determined for a quarter bend acted on by a moment perpendicular to the plane of the bend.

Modification of the grapho-analytical method to enable the Vigness' effect to be taken into account will be discussed in an article describing the application of that method. Further experimental work on transverse bending of welding fittings and observation of their cross-sectional deformations were reported by Vigness in a discussion of the paper by Beskin[28] as having been made at the Naval Research Laboratory. It was stated in that discussion that these results would be published in the near future. One significant point mentioned by Vigness was the effect on flexibility of restraint at the ends of short-radius bends (welding elbows) by flanges or adjacent tangents that restricted deformation of the circular cross section.

Brief descriptions of a number of the current methods of determining the flexibility of piping layouts are given in the following paragraphs:

### Grapho-Analytical Method

The grapho-analytical method given in the Piping Handbook[10] in-

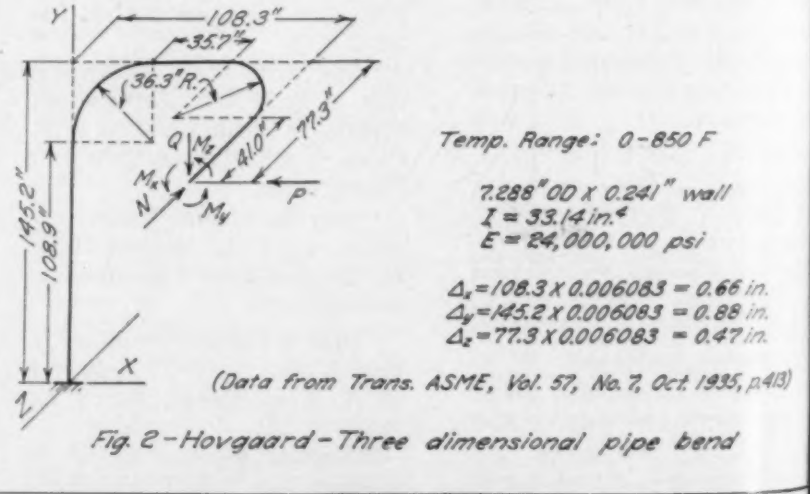



Fig. 2 – Hovgaard – Three dimensional pipe bend

volves a step-by-step solution which is readily visualized. The existence of a graphical picture plus the numerous checks available on the accuracy of the work are among its advantages over other generalized methods. Its simplicity when applied to square-corner approximations would seem to require further emphasis.

### Algebraic Method

In addition to the grapho-analytical method, a number of orderly procedures have been developed which also eliminate need for a knowledge of calculus and reduce the solutions to simple algebra. The evaluation of the various integrals merely involves substitution of numerical values in equations or tables. The fundamental equations developed by Hovgaard[18] form the basis for the so-called "algebraic method" which is best known as the Meyer-Hovgaard method. This procedure was introduced by Noyes,[31] simplified by Bleick,[32] and extended by Austin.[33] Where a large number of layouts are to be checked it apparently has been found particularly workable.

### Shipman's Method

A systematic solution of single plane problems by the use of pre-integrated shape coefficients was presented by Shipman.[13]

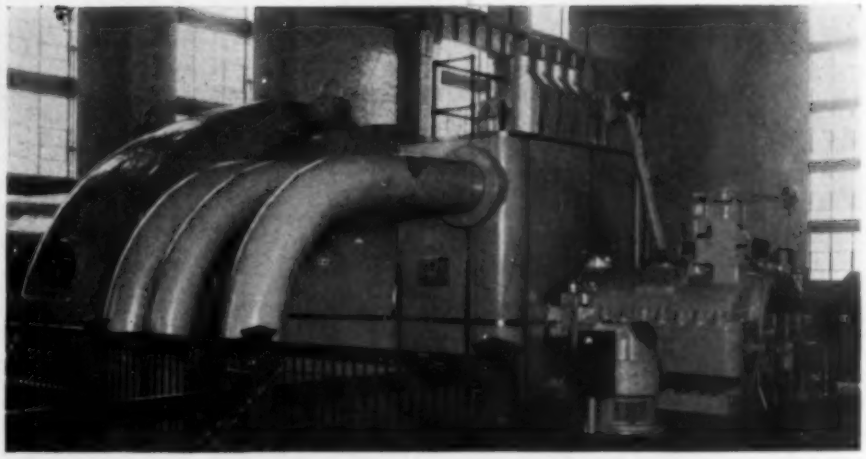
The extension of this method to three-dimensional problems is given in detail in a publication on Design of Piping Systems,[9] by the M. W. Kellogg Co. Credit is given Messrs. G. W. Watts and W. R. Burrows of the Standard Oil Co. (Indiana) for the basic idea used in development of the general method in that publication.

### Elastic Center Method

The elastic-center method, which has been brought to a high degree of development by Messrs. S. W. Spielvogel and S. Kameros,[52] takes advantage of the simplification of placing the center of the coordinate system at the virtual center of gravity of the pipe line.

### Tabular Integration Method

A method, developed by R. C. Powell of the Pacific Gas and Electric Co., makes use of the simplifying assumptions that piping can be laid out parallel to a rectangular system of space coordinates and that arcs can be replaced by square turns. This system leads to simplified solutions for three-dimensional problems. It has not been published as yet, but through private circulation has become rather generally known and is used extensively by the Midwest Piping and Supply Co. Elements in torsion are assumed to be 25 per cent more flexible than those in bending in agreement with Carlier[1] rather than 30 per cent, as in most American developments. This variation facilitates the tabular integrations.



**Main steam and bleeder piping at head end of turbogenerator**

### Graphical Methods

Graphical methods of determining expansion stresses were used by Hovgaard in his earlier papers and the Mitchell[14] method is quite commonly used for approximate solution of one-plane problems. The application of graphical analysis to unsymmetrical lines by Baggerud and Jernstrom gives derivations by both the Castigliano and Hovgaard methods. A graphical solution in which arcs are replaced by tangent lines has been evolved by Peiter[55] and Fish. Three-dimensional piping systems are not so amenable to graphical solutions although approximate relations are obtainable by the Mitchell method or that employed by Cocks[47] and Finniecome.[40]

### Moment Distribution Method

The application of the "Hardy Cross" system and the fundamental conjugate beam theory to problems in flexibility of piping has been made by De Hart.[29]

### Model Test Methods

Model test methods of determining the relations of deflections and force have been developed by Semar,[21] Conrad,[57] Hill,[59] Spielvogel,[60] and Andrews.[62]

### Tabular and Chart Solutions

Tables and charts covering specific configurations, conventional bends, and the simpler shapes are available which are of great convenience. These simplified solutions, given in the Piping Handbook[10] and by Wert and Smith,[6] should be used where applicable as they reduce the computation labor to a minimum.

The nine methods described are those believed to be of current interest, although modifications of several of them doubtless exist which are not mentioned and some may have been overlooked in this review.

In the authors' opinion, the development of less laborious and more simply presented methods of analysis is even more important than the ability to take into account all refinements, but it is believed that by the development of suitable modification tables or curves both accuracy and simplicity may be achieved.

**ON THE BEACH**

Kaufman & Fabry Co.

# Contractors Hold Big Meeting

EVERYTHING conspired to try to keep the members of the Heating, Piping and Air Conditioning Contractors National Association in Atlantic City even after the close of the organization's convention last month—the weather was perfect, and the railroad strike made it impossible to leave by train when the final session adjourned. However, the ingenuity of the master steamfitter came to the fore, and shared rides in private automobiles, chartered busses, and a chartered plane got the majority of the gang out of town and back to the job. One group, Chicago-bound, hired a taxi for the 900 mile trip. Several conventioneers (the smarter ones, it seems now) decided that a little beachcombing in May on the Atlantic coast beat returning to the problems of material and manpower shortages facing them at home, and planned to sit out the railroad confusion at the Ritz-Carlton, where they had bed, board, sunshine, and the sound of the surf.

Around 450 contractors and guests were registered for the meeting, the first held since the Cleveland convention two years ago, and were on hand to see Roy M. Getschow, president of Phillips Getchow Co., Chicago, take over the national presidency of the HPAC-CNA from Daniel Hayes, of San Francisco. James M. Anderson, Philadelphia, was elected vice president.

Following the opening ceremonies of the first session, at which Secretary Joseph C. Fitts, New York City, gave his report, and Treasurer Thomas L. Eagan, Washington, D.C., announced that the association was in better financial shape than at any time in its history, George S. Van Schaik, vice president of the New York Life Insurance Co., discussed the interest of the life insurance companies in construction of housing. This interest stems from two sources, he said: the natural interest of such companies in decent, standard, and sanitary housing for the populace because of the relationship of slums to disease; and the insurance company problem of investing funds safely at an adequate return.

Mr. Van Schaik stressed the extreme importance of providing housing as quickly as possible, and said that for a temporary period materials must be channelled to the places where they are needed the most—low cost projects. This interim period need not be very long, he thought, due to the country's productive capacity—and it won't be as long, in fact, as a lot of people seem to think, he said.

The No. 1 problem of the city is decay at the core, he said, and he foresees a large volume of big construction coming in the future to meet this problem. He then discussed large apartment developments such as Parkchester, in New York, which—by their very size—"create their own atmosphere" and are thus "insured" against premature obsolescence. He predicted very great activity on the part of insurance companies in financing projects of this nature, and said that the idea that real estate investments are speculative was outworn and that proper planning, operation, and maintenance of big apartment housing projects can make them sound investments.

**Big Construction Volume Coming**

Mr. Van Schaik announced that his own company was going forward with a 141 acre, 3000 dwelling unit, garden type development in Queens "with construction costs as they are," and that it will be a perfectly safe investment with analogous interest rates to mortgage investments.

Closing with the plea to "join me in my optimism," Mr. Van Schaik said that it was his opinion that the building industry "was on the brink of the greatest days it has ever seen." He quoted Elihu Root's statement that "one of the main

# Radiant Heating, Housing Projects Discussed at Atlantic City Convention of the HPACCNA

**IT LOOKED for a while as if those attending the annual convention of the Heating, Piping and Air Conditioning Contractors National Association would be marooned last month in Atlantic City, but chartered planes, busses, long-distance taxis, and the end of the rail strike finally enabled everyone to get out of town. . . . It was a lively and enjoyable meeting, well-attended and with a lot of good information presented. While material shortages were perhaps the main topic for corridor discussion, the contractors found time to dig rather thoroughly into radiant heating, housing developments, heating small homes, pipe welding, etc.**

duties of citizenship was hopefulness."

### Higher Building Standards

In commenting on Mr. Van Schaik's remarks, George P. Nachman stated that amortization periods for real estate investments are apparently being lengthened, and that this must mean higher building standards and, therefore, higher building costs. He said that lending agencies must realize this trend, and also that the public is demanding more equipment inside a building today than was the case a few years ago (air conditioning would be an example).

The report of the association's committee on trade promotion, by Wray M. Scott, chairman, led off the second session of the conference. In his remarks supplementing the official committee report, Mr. Scott gave some figures on an overhead survey of some 160 shops which—he said—represented a good cross section of the industry. The total purchase of materials for the year covered by the survey amounted to $23½ million. The total net profit was $3.7 million, which represented 14.8 per cent on invested capital or 3.8 per cent on sales volume.

### "Answer to Contractor's Prayer"

J. A. Ljunggren, chairman, then gave the report of the home heating committee, which comprised mainly a recommendations booklet copyright by the HPACCNA showing a "type W-2" panel heating system designed to heat a small one story house with concrete floor laid on earth, and two modifications of the "type W-1" system, one showing the application of baseboard radiators and the other showing a forced flow hot water heating system using direct radiation, with a gas fired boiler placed in the attic. Mr. Ljunggren commented on the wide variation in estimates of cost on the panel heating system made by various contractors to whom plans and bills of material for the installation had been sent. In his remarks, Mr. Ljunggren said that "the baseboard radiator is the answer to the heating contractor's prayer," inasmuch as it removes the objections of owners to the use of radiation.

There were a number of questions from the audience on the use of baseboard radiation; one contractor wanted to know if it was possible to get enough such radiation into the ordinary room—the answer was "yes," and it was also stated that it was perfectly possible to use supplementary radiation of some other type along with the baseboard surface.

Harry M. Hart, in his comments on the subject, expressed the desirability of standardizing on the Btu emission per sq ft of radiation with hot water heating installations, and said that all engineers and contractors should use the same basis for design. Mr. Hart also said that credit should be given in figuring building heat requirements to the heat losses from the piping, the hot water tank, and the boiler, as indicated by the results of tests made at the University of Illinois.

The next order of business was the presentation of a summary of a survey on the kind of heating system the buyer wants, by R. E. Ferry of the Institute of Boiler and Radiator Manufacturers. He gave an extensive series of figures representing the views of builders and architects, breaking them down to show trends in different sections of the country. In concluding, he stated that he believed the veterans' housing program would necessitate a great number of multiple dwelling units, rather than single family homes, due to the required low cost per unit; this, he said, would tend toward the use of boiler and radiator heating as compared to warm air jobs.

### Can't Beat Radiant Heating

You can't beat radiant heating these days as an attention-getter. When George P. Nachman, of Spohn Heating & Ventilating Co., assumed the chair (or, rather, the platform, for he stayed on his feet throughout most of a lively session) to call a discussion on the "why and how" of panel heating to order, the audience moved forward almost as a man, those who had been chatting in the outer hall came into the meeting room, and the entire atmosphere was one of great interest.

The radiant heating session had been well planned, and was well presented. In his introductory remarks, Mr. Nachman said that "standards for radiant heating must come." He then introduced the first of the four speakers (each of whom had been allotted 12 minutes)—Peter B. Gordon, of Wolff & Munier, Inc. Mr. Gordon gave a wealth of data on application details for panel heating, and particularly the installation of coils in plastered ceilings. He then discussed English and American practice for such work, and included many helpful hints on proper methods. He devoted most of his remarks to the use of radiant panel heating in multi-story buildings, and said that the American Concrete Institute was revising its code requirements for extra slab thickness for structural concrete in order to cover radiant heating coils with a certain thickness of concrete.

R. G. Vanderweil, Chase Brass & Copper Co., next spoke on physiological conditions with radiant heating, and said that it was the "ideal" heating method, inasmuch

**Lots of interest was shown in radiant heating**

as it gives conditions inside a building similar to those outdoors on "a calm, sunny, spring day." There are 10 points that cause this comfort, he said: air is cool, air is calm, no air stratification, relative humidity is "just right," lack of suspended dust, no discoloration due to dust, no unpleasant odors, lack of small hot spots in room, all surfaces are of even temperature, and radiation is from above (with ceiling installations). Any heating system is only as good as the designer, he stated.

The human race is used to receiving radiation from above, Mr. Vanderweil said, and for this and other reasons he prefers the installation of the heating coils in the ceiling. The ceiling system has the edge over the floor, he felt, although the type of building and construction cost are of course involved in a choice (a garage, for example, is a "natural" for a floor job). He said that the engineer should design for the most even surface temperature possible throughout a room, but that heat should be concentrated near cold wall surfaces or windows, and the hotter water should be supplied near walls.

C. A. Hawk, Jr., of the A. M. Byers Co., then spoke on "frontiers of panel heating," and said that "a lot of water had flowed over the dam, and through radiant heating systems" since the hot night in Cleveland two years before when the same subject had been discussed at the contractors' convention. He said that radiant heating was a rapidly changing field.

Garage repair shops are among the greatest users of radiant heating at the present moment, he stated, and in some cities he has noticed that garages are using their installations as an inducement in their want ads in the classified advertising columns for mechanics. Radiant heating installation costs in garages are running 10 to 20 per cent above the cost of unit heater systems at the present time, he remarked.

A large number of aircraft hangars will employ radiant heating, he predicted, there being eight or 10 such jobs now in existence. Another type of installation to watch, he said, is the application of radiant heating coils for snow melting at airport runways, passenger loading areas, loading docks, etc.

### Avoids Ceiling Condensation

A large textile mill in Canada avoided a $20,000 expenditure for a ventilating installation to prevent condensation on the ceiling by installing a ceiling panel heating installation, he said, and explosives manufacturers have used radiant heating in connection with the curing cycles for their products. An unusual installation now on the boards is an outdoor theater in California, with heating pipes imbedded in the ground slab to keep the patrons' feet warm. Another unusual structure employing radiant heating is an outdoor refreshment pavilion whose only sidewall is in the form of a 90 deg arc on the windward side.

As for estimated cost variations between different radiant heating installations, the underlying factor is uncertainty on the labor cost, which will be clarified as more and more contractors obtain experience with radiant heating. Experience breeds low cost, he said.

### Copper Tube Method

J. L. Bradfield, Taco Heaters, Inc., then took over the speaker's platform to describe "new developments in copper tube installations" for radiant heating. He not only discussed the use of 5/16 in. OD copper tubing with 30/1000 in. wall for this purpose, but also demonstrated the handling of the tubing and joining it to the supply and return headers by means of a mechanical joint made by a roller tool which he has developed.

A unit length of loop of 20 ft is used as standard in this method, and the tubing can be had from jobbers boxed in straight lengths. By means of prefabricated headers with saddle fittings, and with the tubing loops formed by hand, different heat emissions per square foot of ceiling area may be obtained because the headers may be had in two different spacings, and the supply and return header openings may be staggered. The heat emission is 288 Btu per 20 ft loop of tubing, and by different arrangements of loops and headers, heat emission values per square foot of ceiling surface of 38, 57½, 76, or 115 Btu may be obtained. By popular demand from the audience, Mr. Bradfield ran well over his allotted time of 12 minutes explaining and demonstrating the scheme, and answering numerous pertinent questions.

[Our report of this convention will be completed next month.]

# Engineer, Physiologist & Psychologist Are Involved in Heating, Conditioning

***B. von Haller Gilmer, Associate Professor of Psychology, Carnegie Institute of Technology, Discusses Body Temperature Sensitivity, Control***

OF THE many phases of human adjustments, the one most closely related to problems of heating and ventilating is that of bodily temperature regulation. The human organism operates with maximum efficiency at an internal temperature of about 100 F, and maintains this level within 1 or 2 F. If the external temperature becomes too high, the body automatically meets the emergency in a number of ways; when the environment is too cold, different adjustments are made without voluntary control on the part of the individual. However, man has always controlled his environment in certain ways in order to supplement the natural processes of bodily temperature adjustment. When he is too warm, a man will avoid muscular exercise, retire to a cooler environment, wear less clothing, and eat fewer heat-producing foods. Similarly, adjustments to cold involve the use of clothing, housing, and deliberate muscular exercise. The most elaborate of these controls of environmental temperature involves the use of regulated heating, ventilating, and air conditioning.

Some of the detail processes of temperature regulation are known but many problems still await solution. These are problems for the engineer, the physiologist, and the psychologist. Some of them can be worked out independently and others will require coordinated attacks. The purpose of this paper is to give the engineer a description of some of the psycho-physiological principles of bodily temperature adjustment and the mechanisms of the skin that operate in the perception and control of temperature changes.

The heat regulating center in man is the hypothalamus of the brain and its function resembles that of a "central thermostat." Stimulation of the heat receptors of the skin activates the hypothalamus, reflexly producing dilation of the skin blood vessels and increasing sweating—thereby increasing heat loss from the body. At the same time heat production may be cut down through general muscular relaxation. Cold stimulation of the body causes the reverse effect, which occurs also as a reflex activity. There is a constriction of the skin blood vessels and sweating is decreased, thereby conserving bodily heat which is being automatically produced through increased muscle tone. What is the structure of these microscopic mechanisms of the skin, how do they operate in controlling bodily temperature, and what function do they perform in giving us our sensations of warmth and cold?

**Warm baths should be used for cooling off** Acme

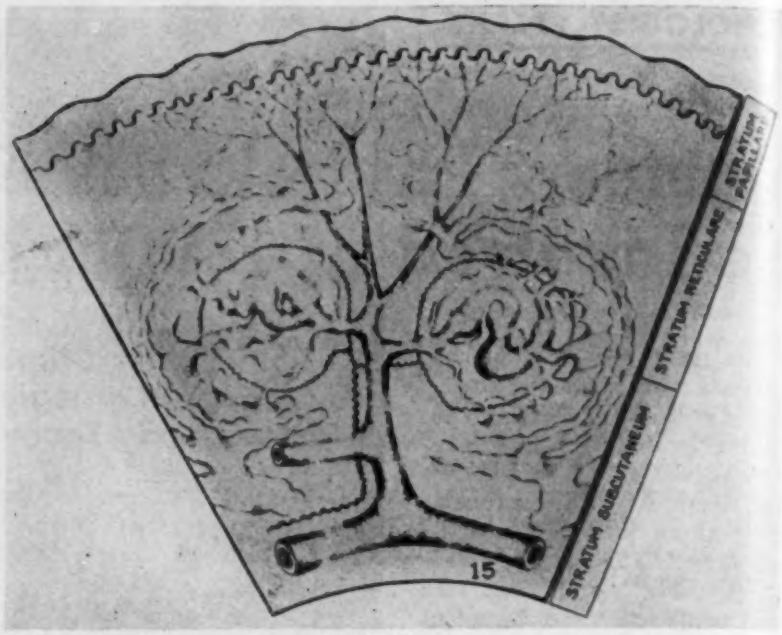
Located beneath the surface of the skin in the dermic and subcutaneous fatty tissue are literally thousands of small "thermostats" which function in the regulation of body temperature. These tiny mechanisms, which connect the small veins with the small arteries, are called arteriovenous anastomoses or *glomus bodies*. This latter term is descriptive of the shape of these microscopic regulators—little "ball-like" bodies. These glomus bodies, which are about 150 microns in diameter, have something comparable to elastic membranes and are richly supplied with tiny muscles and nerves. As blood flows into these bodies they expand—as blood flows out, they contract. It is through this expansion and contraction that they function as "local thermostats." In a warm environment the glomus bodies expand and

fill with blood, thus bringing the blood closer to the surface of the skin where the body heat is dissipated. Aiding in this process of heat loss are thousands of sweat ducts. When there is little water vapor surrounding the body (low humidity), evaporation of sweat is an effective cooling mechanism. But when humidity is high, the evaporation of sweat is hindered and loss of body heat is restricted.

Under conditions of a cold environment the glomus bodies contract, forcing blood away from the surface of the skin. The skin also "tightens up" and sweating is lessened, thus conserving body heat. Clark and Clark (2),* using the ingenious method of transparent windows, observed these expansions and contractions of the glomus bodies in a rabbit's ear, and their data confirm the assertions that the glomus bodies dilate and contract under conditions of warming and cooling.

When adequate thermal stimuli are applied to the skin, they give rise to two characteristically different qualities of experience—the feelings of *warmth* and *cold*. When the skin is touched by warm or cold objects the perceptual experiences aroused depend not on the absolute temperature of the physical stimulus, but on the differential relationship between the temperature of the physical stimulus and that of the skin at the moment of stimulation. That is to say, a physical stimulus of the same temperature as the skin will arouse a thermally indifferent experience, being neither warm nor cold.

The temperature of the skin at the point of indifference is known as *psychological zero* (or *physiological zero*). The physical value of this psychological zero point shifts up and down according to one's health, activities, and environment, and also varies from one part of the body to another, being lower in those regions that are sparsely supplied with blood. Under normal conditions, the psychological zero point on most regions of the skin is about 91 F. The zero point may be lowered by cold applications and raised by warm ones. Thus, if the left hand is placed in warm water and the right hand in cold water,




**Diagrammatic presentation of the glomus body as found in the finger tips. See text for description. (After Dr. Popoff, Arch. Path., 1934, 18, 306)**

and after a few minutes both hands are placed in water of neutral temperature, the water will seem cold to the left hand and warm to the right hand. This contrast occurs because the zero point has been raised in the left hand and lowered in the right, so that the water of neutral temperature is now above psychological zero for one hand and below for the other.

As the temperature of a stimulus is increased above psychological zero, it will arouse a sense of warmth which grows more intense as higher temperatures are reached. Above about 115 F, pain begins to occur also, so that the experience evoked by a very hot object includes pain as well as warmth. Similarly, when temperatures applied to the skin are below the psychological zero point, experiences occur which are graduated from cool to cold. Below a temperature of about 50 F, some pain is also experienced; very cold objects provoke notably painful sensations.

The skin is not uniformly sensitive to temperature stimulations. When a metal point which is a few degrees above the temperature of the skin is drawn across an area, certain diffused spots will be found that give a more vivid experience of warmth. Similarly, if the point is cooler than the skin, tiny cold spots will be found. To study the relationships between these temperature "spots" and their underlying tissues, experimenters (3) have cut out some of these spots and made an histological study of the tissues beneath. These investigations have led to the contention that the glomus bodies of the skin function not only as "temperature regulators" but also as the sensory mechanisms for temperature feelings.

It is postulated that a contraction of the glomus bodies results when a cold stimulus is applied to the skin near one of the organs and this contraction gives rise to nerve messages which register "cold." This contraction is caused by a re-

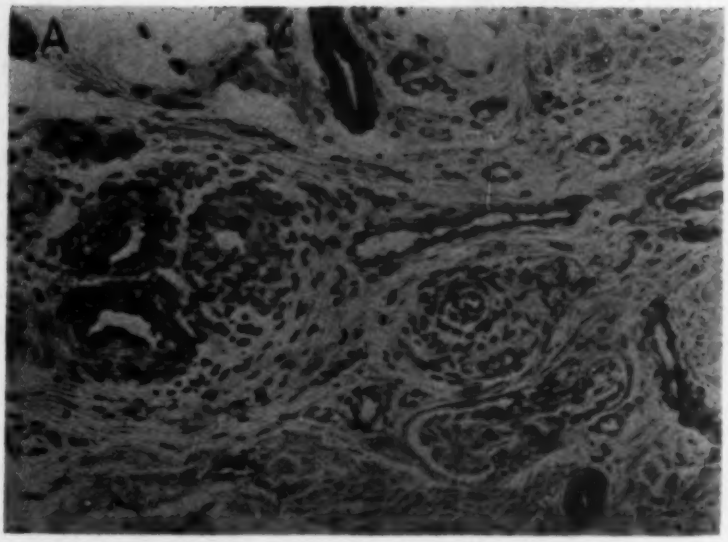
**HEATING and air conditioning are so intimately involved with the human body that the physiologist and the psychologist—as well as the engineer—are involved. Dr. Gilmer's purpose here is to give the engineer a description of some of the psychophysiological principles of bodily temperature adjustment and the mechanisms of the skin that operate in the perception and control of temperature changes . . . A point he mentions in conclusion is that it is human nature for some people to "over control" in setting thermostats, instead of giving the bodily mechanisms a chance to adjust to the room temperature.**

*See references at end of article.

lease of heat from the organ. Adequate release of heat from the deep-seated glomus bodies is facilitated by sweat ducts. The more peripherally located glomus bodies have little temperature insulation between them and the point of stimulation, and, therefore, do not need such temperature conductors. The application of a warm stimulus to the surface of the skin causes dilation of the glomus bodies and hence the experience of "warmth" is sensed.

The sweat ducts have long been recognized as important mechanisms in aiding in the release of body heat. The writer (4), in a series of experiments involving 13,000 stimulations of the skin with a cold stimulator, found about twice as many cold "spots" at the mouths of sweat ducts as were found in those skin areas not containing sweat duct openings. These investigations, combined with evidences obtained from histological studies of the tissues of the skin, lead to the belief that the sweat ducts are of primary importance in bringing about bodily comfort by helping to regulate heat loss through the skin.

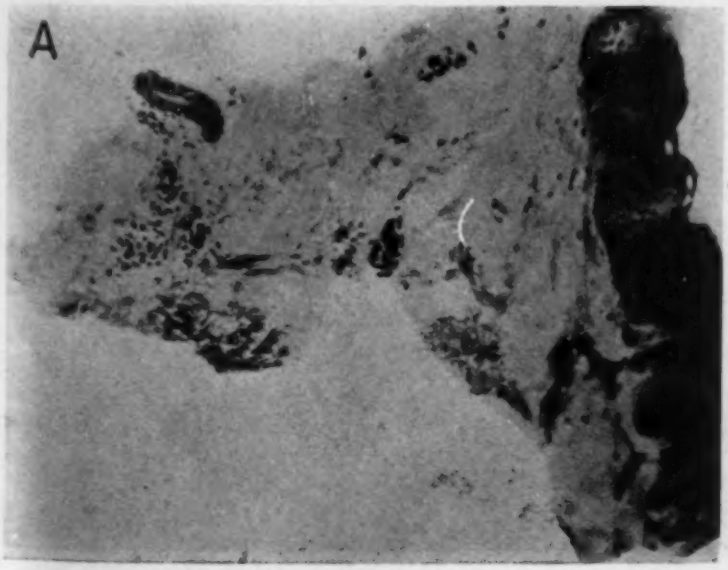
Besides maintaining body comfort through regulating clothing, diet, and exercise, man can apply other everyday procedures in controlling his temperature. Warm baths are more cooling "in the long run" than are very cold baths. The warm bath will dilate the glomus bodies moderately, open up the pores of the skin, and increase the flow of perspiration—all of which releases internal bodily heat. Although the cold bath will give a temporary feeling of cooling off due to constricting the glomus bodies, thereby producing the sensation of cold, the effect is not lasting. The tissues will be constricted and sweating will be reduced, causing the conservation of internal heat. Paradoxical as it may sound, warm baths should be used for cooling off and cold baths for conserving bodily heat. Extremes of both temperatures should be avoided for the most adequate physiological adjustments—this applies likewise to heating and air conditioning of buildings.




**Magnified section from the ball of the toe, showing a cross section of two glomus bodies. The canal-like structure at the top of the picture is a cross section of a sweat gland duct. Highly magnified[3]**

It is human nature for some people to "over control" in setting their heating or air conditioning thermostats. Instead of giving the bodily mechanisms a chance to adjust to a normal temperature of 72 F, they will move the control up and down, thereby forcing the bodily mechanisms into a fluctuating rhythm of dilation and contraction. Although the average person is aware of the nature of such adjustments as visual adaptation, many people do not fully appreciate that a certain amount of time is required for a temperature adjustment. When one enters a darkened theater, it requires several minutes for dark adaptation to become effective enough for one to see adequately. Similarly, a temperature adjustment can be obtained in a building within a few minutes, provided the environmental temperature is held constant long enough for the bodily mechanisms to become adjusted.

**Section of skin containing a "cold spot." Note the glomus body at the lowest point of the specimen with a sweat gland duct above it. The black portion at the right of the picture is the outside covering of the skin. Magnification, 25[4]**

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**STIMULATES THINKING**

# Should We Use Unit Heaters or Radiant Heating in Factories?

## *M. J. Druse Outlines Advantages of Units*

TO JUDGE from the reams of radiant heating editorial copy which are being published in the trade and business press as well as in the general magazines, all other heating methods will be pathetically obsolete within the next five to 10 years.

There is no question but that radiant or panel heating, being one of the newer developments, is a "hot" subject today. Everyone wants to know more about it—a perfectly normal indication of the healthy curiosity for which the American people are noted. But, as Heating, Piping & Air Conditioning pointed out in its February issue, "In the final analysis of any particular installation, its advantages must be weighed against other types of heating, in the light of *experienced engineering and practical judgment for the job to be done.*"

The author's company has never believed—nor does it now—that radiant heating is the answer to industrial plant comfort. It recognizes only a limited number of industrial applications where radiant heating is feasible. In any thorough comparison, factual installation data on both types of systems is important. That type of data on radiant heating in volume sufficiently large to carry weight or in volume comparable to that available on unit heaters, is obviously not to be had.

Merely to stimulate critical thinking on the subject, this article reviews the following inherent advantages of unit heating which seem to have been lost in the shuffle but which *must be considered in any comparative analysis of the two methods as regards industrial heating.* These by no means exhaust the points in favor of unit heating. They are merely *some of the fundamental advantages which have made unit heating industry's standard method.*

### Adaptability to Plant Changes

Production areas and plant layouts generally are subject to change and revision. New machines are added, older ones are replaced. New aisles are made; new assembly lines are established. Storage spaces are converted to working areas . . . and vice versa. Changes such as these are frequently accompanied by changes in areas to be heated and in temperatures to be maintained in these areas. For example, relocation of drying or baking ovens, brazing furnaces, etc., invariably set up new comfort heating requirements.

Unit heaters, being semi-portable, are easy to relocate or redirect, normally involving only changes in branch supply and return piping and electrical connections. Redirection of heated air stream is even simpler. With unit heaters, the heat distribution patterns are not permanently fixed . . . and, like light distribution patterns, are very flexible and easy to change.

Because manufacturing floors are likely to be torn up to accommodate new machinery installations — *and this means tearing up in-the-floor grids too* — overhead unit heaters have a definite advantage here. Interference by steel girders and the possibility that walls, like floors, may be torn out to permit new or re-arranged production lines, discourages location of heating grids in the walls of the average industrial plant. Where there is definite assurance that production areas and machinery locations will not change, and where the original heat distribution pattern will always meet future requirements, radiant heating is feasible.

### Flexible Zone Control

A unit heater system is analogous to a modern lighting system in its flexibility of control. In fact, no other heating method lends itself so naturally and economically to zone or area control as does a unit

**A unit heater system is analogous to a modern lighting system in its flexibility of control**

heater system. Individually or in groups, like lights, unit heaters can be operated to serve only those specific areas where heat is needed—without the necessity of maintaining comfortable temperatures in adjacent areas temporarily not in use. For example, when night shift operations are limited to a few widely separated production areas, only the units serving those areas need be operated. This flexibility of control is also advantageous to quickly counteract variations in heat loss in an industrial plant in cold weather due to high winds or the opening of large doors. Heat recovery in a given area is exceptionally rapid with unit heaters.

While it is true that a good radiant heating system incorporates zone control through the use of circulating pumps, mixing valves, lock-shield balancing valves, and immersion thermostats, accurate temperature control of zones generally involves a relatively complicated and expensive control system as compared with the simple, inexpensive thermostatic or manual controls used on unit heaters. Even with an elaborate control system, radiant heating can not approach the close and variable control of room temperatures in a zone *or in an area within a zone* which is possible with unit heaters. This difference is comparable to the night workman who turns on the light directly over his machine instead of lighting an entire bay. (Tomorrow night he may be working on another machine in a different part of the plant.)

### Fuel Costs

In considering claims of fuel saving possible with radiant heating, the fuel required to heat areas not in use, hence not requiring heat, should be entered on the debit side of the radiant heating ledger. Only with unit heaters (as explained above) is it possible to coordinate heat distribution (fuel consumption) so closely with the need for heat in a specific area.

### Quick Warm-Up

With unit heaters, working areas can be warmed to comfortable temperatures within a very short time after the units are turned on. This is especially desirable after week-end shutdowns and eliminates pro-

**Working areas can be warmed-up quickly**

longed warm-up periods or operation of an entire grid system (at lower temperatures) over a week-end. Here again, fuel saving should be considered. The quick response of unit heaters (without anticipatory controls) to heat demands caused by sudden changes in outside temperatures deserves consideration in any comparison of the two types of systems.

### Air Circulation and Ventilation

While the adherents of radiant heating point out that the absence of air circulation prevents distribution of dust in a plant, it is generally recognized that air circulation is desirable for health and comfort. In fact, a very definite number of air changes are usually specified by heating engineers for most industrial heating systems. Unit heater systems can be designed to provide the necessary air changes per hour *without the use of supplementary fan equipment.*

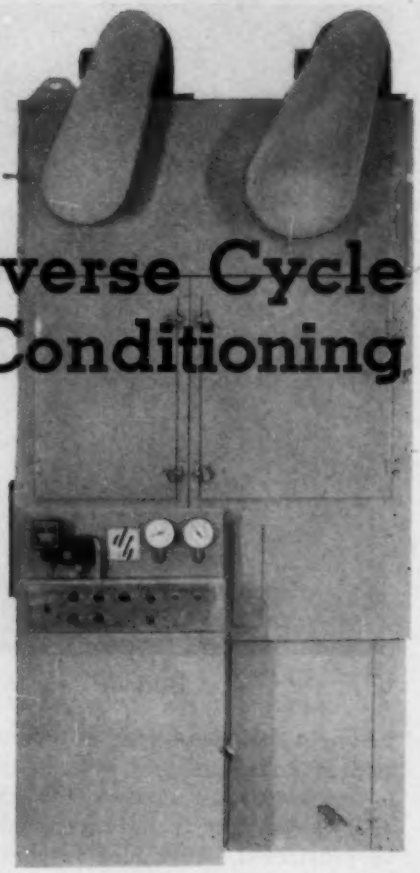
Tempering and introduction of outside air to meet health codes or individual plant requirements can be handled by unit heaters installed in conjunction with ducts . . . again without separate equipment which would be needed in the case of radiant heating.

A unit heater system can be used to excellent advantage in the spring and summer months by operating only the fans. In this way it is possible to provide well-planned, cooling air circulation throughout an entire plant without the need for installing independent fan equipment at random locations.

**THERE'S BEEN so much published, and so much interest in the subject of radiant heating that one might think that all other methods of supplying heat to a building have become obsolete. "It ain't necessarily so," says Mr. Druse, of the Modine Mfg. Co., in this review of the inherent advantages of unit heaters as applied to industrial plants. The heating method for any particular building must of course be selected in the light of experienced engineering and practical judgment for the job to be done**

### Other Considerations

In this discussion the subjects of warm floors, the making of repairs and replacements to an imbedded system, and comparative system costs have purposely been avoided. There have not been enough radiant systems in industrial plants to provide conclusive data on these controversial points. But speaking positively from experience in *thousands of installations* over a more than 20-year period, we do know that these present no problem in unit heater systems.



Factory built, self contained units are quite possible and advisable in sizes up to 15 horsepower, says the author

# Using the Reverse Cycle for Heating, Conditioning

By G. E. Clancy

SOURCES of basic heat supply or heat disposal when using the reverse refrigeration cycle for heating buildings in winter, and the same equipment for cooling in summer (that is, heat supplied to evaporator in the heating cycle and means of discarding heat from the condenser in the cooling cycle) may be generally classified as follows:

### Outside Air as Heat Source

For cooling cycles, the outside atmosphere has a wide use where such devices as cooling towers or evaporative condensers are included. In this case, the heat discard temperature approaches the wet bulb temperature of the outside air. For the heating cycle, however, such a procedure is not advisable, because the use of water sprays would involve limiting the temperature level of heat absorption to an approach to the wet bulb, not the dry bulb, temperature. Also, in almost any climate in the U. S. A. there would be times when the water would drop below the freezing point.

Straight dry air condensing and heat absorption has much merit in the parts of the country which do not have a severely cold winter climate. Generally this includes nearly all of the southern half of the United States.

The advantages of an air system are:

1) A quite satisfactory balance between heating and cooling performance.

2) Elimination of troubles resulting from scale, incrustation, and dirt or mud often found in water.

3) Greater simplicity.

4) The plant may be built to a standard design or packaged unit, in smaller sizes (up to about 15 tons, or 180,000 Btu per hr).

5) Dependence of the plant performance only upon climatic conditions, and not upon various additional factors such as water supply, water temperature, disposal of water, hardness of water, etc.

6) Serious freeze-ups cannot occur.

The disadvantages of an air system are:

1) The lowest ratio of performance and the lowest maximum heating capacity occur at the lowest outside temperatures.

2) The power required for circulation of the air is a considerable factor because air is a gas with a comparatively low density and a low specific heat; consequently, large volumes of it must be handled.

3) Under some conditions of operation there may at times be a troublesome accumulation of frost on the evaporator surfaces. However, recent cycle developments and defrosting techniques have to a large extent eliminated this factor.

4) The apparatus is somewhat larger in physical dimensions but not necessarily heavier than a unit using water instead of air.

### Water as Source of Heat

In localities where city water is plentiful and available at reasonable rates, it may be used quite advantageously if its highest temperature is not over 80 F and its lowest not less than 40 F, provided, of course, that means for disposal of waste water are available.

In this connection, it must be observed that in such localities tap water would be preferred in the summer for cooling, if combination systems of combustion heating and compression cooling were used; hence, with the same total amount of complete air conditioning, the provision would have to be made for part time utilization and disposal of as much water as would be required for year around air conditioning with reversible cycle refrigeration. If steam jet or absorption systems are used in place of compression systems, the amount of heat discarded is considerably larger, usually from two to four times as great; hence, the quantity of water wasted is larger (possibly as much for summer cooling alone as would be required for both heating and cooling seasons combined if reversed cycle compression refrigeration were used).

The advantages of using city water as the heat source are:

1) The plant is somewhat smaller and more compact.

2) The water temperature is not subject to a sharp drop in temperature coincidental with a period of unusually cold weather.

3) The lowest water temperature is somewhat higher than the lowest outside air temperature, and the highest water temperature is below the highest outside air temperature.

The disadvantages are:

1) Possibility of scale, incrustation, and corrosion.

2) Performance and advisability of installation are dependent on local conditions.

In many cases the use of water from lakes, wells, the ocean, etc., may be found quite attractive, especially for larger projects, but the entire design is dependent upon local conditions. Before selection or design, complete data as to year 'round temperatures, hardness, pumping cost, etc., must be available and carefully analyzed.

In some cases waste water from industral processes and the like may be worth considering, but the possibilities are so varied and so extensive that we need here only state that the individual case must be studied and analyzed carefully.

### Schemes of Application

There are numerous schemes or systems of application, some of which are patented, some of which are more or less universally adaptable, and others which are usable only in special instances. These may be generally classified as:

1) Direct application of heating or cooling to the conditioned air stream, with direct heat absorption or rejection to outside atmosphere.

2) Direct application of heating or cooling to the conditioned air stream, with heat absorption or rejection to water from city mains or other source.

3) Indirect application of heating or cooling to the conditioned air stream through an intermediate heat carrying vehicle (usually circulating water) with heat absorption or rejection to water. (The absorption or rejection could, of course, be to outside air; however, the writer knows of no such projects, nor does there seem to be much occasion for them).

Class 1 may be further divided:

a) Systems which change from one cycle to the other (heating and cooling) by switching the air streams, with or without subcooling, sometimes provided with an extended surface water coil for preheating of make up air or for all of the outside air from city water in an emergency, and other additions may be made (see Fig. 1).

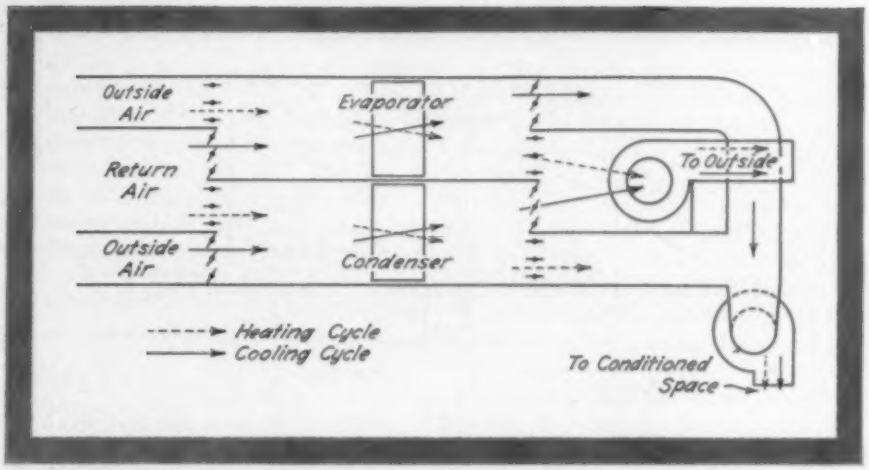



**Fig. 1—Systems which change from heating to cooling by switching the air streams have merit, for the refrigeration cycle is always the same**

This system has considerable merit in that the refrigerant cycle is always the same and the evaporator and condenser always serve the same purpose in the same way. The air is handled exactly as desired, in the proper portions, and heat is not deliberately wasted once it is introduced into the air stream. But since the quantities of air for the two circuits are very different, it is difficult to design the evaporator and condenser coils to work efficiently at the two very different air volumes and consequently different air velocities. The face area of both blast coils must be large enough for the larger quantity of air, which in addition to the elaborate and extensive system of switching dampers makes the plant quite large and bulky. It is difficult to be sure that all of the synchronized dampers close tightly or open completely. This is a reasonably good system, but it is difficult to design in a manner to obtain good balance. It is bulky and the first cost is rather high.

**Fig. 2—In this scheme, on either cycle, air at the same condition is supplied to both evaporator and condenser**

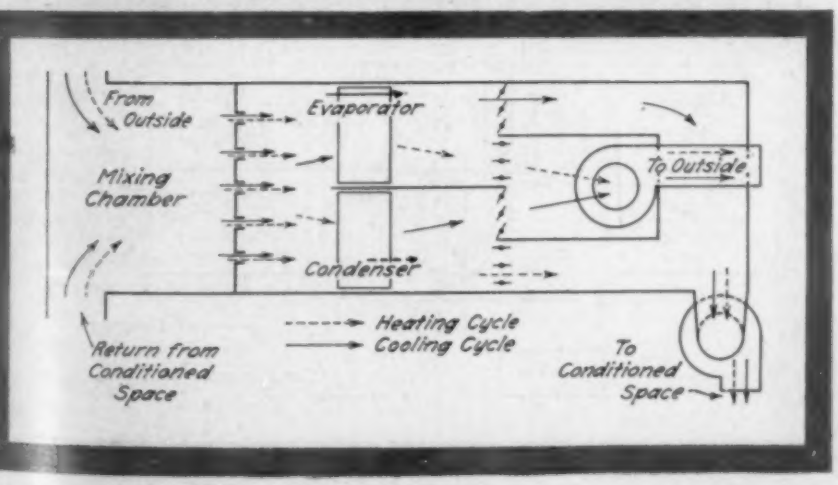



Fig. 2 shows a semi-regenerative system; on either cycle, air at the same condition (mixture in equal quantities of outside and returned air) is supplied to both evaporator and condenser, one-half of the total air stream being heated and the other cooled, then the one required for the conditions conducted to the conditioned space and the other discarded.

In mild climates, and where a large amount of ventilation air (about 50 per cent) is desired, this system may often be used advan-

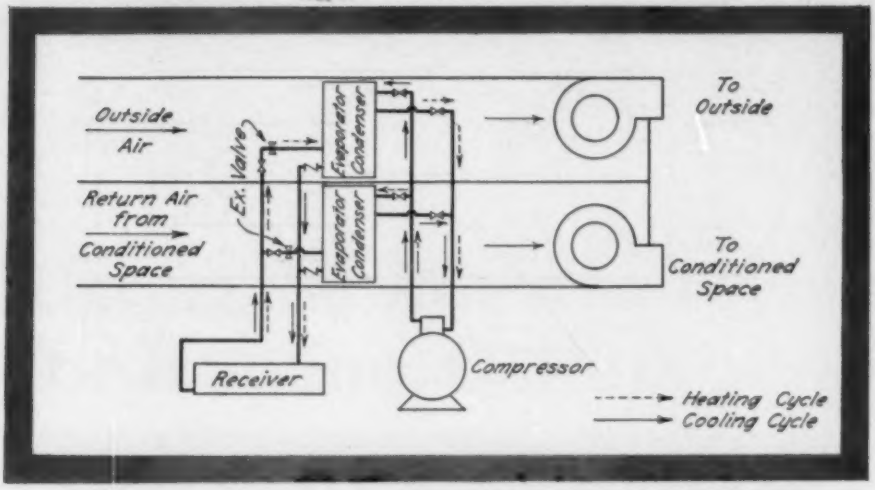



**Fig. 3—In this type of system, the air circuits remain unchanged and the space required is not as great as when air switching is used**

tageously. Its performance may be very considerably improved by precooling or preheating the outside air taken in. Such a plant is reasonably compact and not unduly complicated. The air volumes through evaporator and condenser are essentially constant and equal.

There are several other possible arrangements for air switching systems, but most of them apply only to special cases, such as an application requiring all outdoor air; wherein all of the air returned from the conditioned space is carried through the heat absorption or heat rejection coil (depending on whether the heating or cooling is required) and thence discarded. The possibilities of such systems are usually apparent on inspection of the requirements of the project.

b) Systems using air on both sides, with refrigerant switching for change from one phase to the other.

In this type of system (Fig. 3) the air circuits remain unchanged, and the space required is not as great as when air switching is used. The difficulties lie in the complexity of the switching arrangement and the number of automatic valves which must be used. Also it is difficult to design a blast coil so that it will serve both functions efficiently and reliably.

In this case (Fig. 4) the switching is considerably simplified. The blast coils serve only one purpose and may be designed to perform that one function very efficiently.

The first cost might be somewhat higher due to the duplication of blast coils, but probably not quite double the amount of surface in the preceding scheme. The air friction will be higher because of the duplicate coils.

A new system, developed by the company with which the author is connected, is designed to retain the merits of both methods without the disadvantages of either. In this system (Fig. 5) the primary tube circuits are duplicated, but the secondary surface (continuous plate fins) is common to both circuits. Thus the cost of the blast coils is not much more than for the system shown in Fig. 3, nor is the air friction materially increased over the amount for the system in Fig. 3, yet the tube circuits are single purpose as indicated in Fig. 4 and the simplicity of switching in Fig. 4 is retained. A switching valve for larger size plants (5 to 15 hp) has also been developed, which uses the pressure of the compressor discharge gas to actuate the valve (only very small electric pilot valves being required), thus eliminating large solenoid valves which may be troublesome.

When water is used for heat absorption or rejection and then discarded, we have about the same variety of obstacles and selections.

Where a secondary vehicle is used on the delivery side, the evaporator and condenser are single purpose apparatus and the flow of vehicle (usually water) is switched as may be required for use in a single blast coil which heats or cools the conditioned air as required.

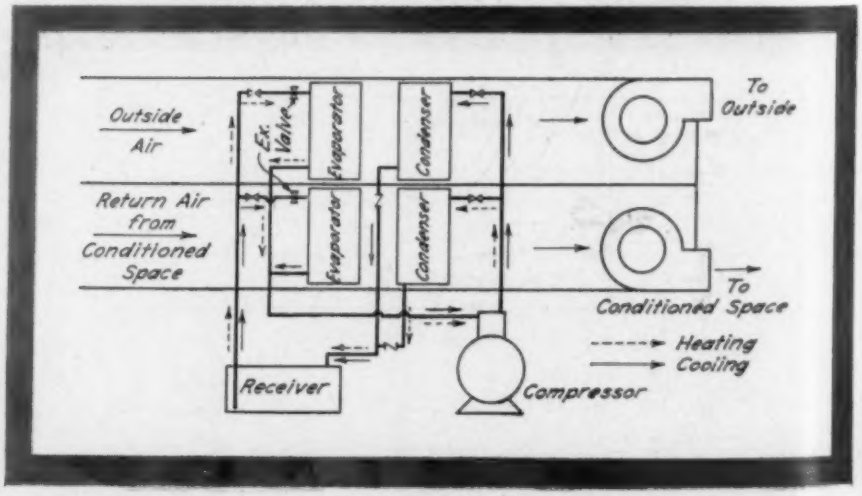
The various possibilities of such systems are so numerous and yet in most cases so obvious that detailed discussion of them does not seem to be advisable here. Such systems are usually only adaptable to large projects of sufficient size to warrant special analysis and design.

### General Design Considerations

The power input is dependent both upon temperature lift and quantity of heat or cold delivered; consequently, it is advisable to use quite liberal air quantities, thus avoiding heating the air supplied to the conditioned space more than 15 or 20 F above the temperature of the room. In the case of cooling, the amount is limited to some extent by the dehumidification requirements.

When air is used for condensing on the cooling cycle and heat absorption on the heating cycle, quite large quantities are usually advisable to prevent freezing and frost formation and to limit the

**Fig. 4—In this case, the switching is simplified**



temperature lift. Large quantities can usually be handled economically because the friction losses on this side of the system are usually quite low. If water is used, similar considerations and qualifications generally apply.

When the temperature of the heat supply to the evaporator, during the heating cycle, is such that the evaporating temperature on the heating side is much lower than that of the cooling cycle, the weight of gas handled by a compressor of a given displacement may be quite different for the two cycles, as a result of the differences in specific volume of the vapor at the two different evaporating temperatures. Consequently, the amount of compressor displacement necessary for proper functioning of the system under the most severe heating conditions may be so large that it will overload the remainder of the system on the cooling cycle. Consideration should be given to capacity control of the compressor, of which there are several which may be used effectively, such as:

a) Variable speed motor or drive.
b) Multispeed motor.
c) Multiple compressors.
d) Booster for heat cycle only.
e) Valve lifting.
f) Clearance pockets.
g) Partial cylinder bypass.

Nearly all of the "tricks of trade" known to the refrigerating engineer may at some time be found useful in reversible cycle design. Most important seem to be examination and analysis of the conditions applying to the project—such as load calculation, weather data, power rates, water sources and temperature, and the careful balancing of power for auxiliaries against compressor power.

**THERE ARE several possible sources of heat when using the reverse refrigeration cycle or "heat pump" for heating buildings, among which are the outside air, city water, water from wells, lakes, and ponds, etc. The advantages and disadvantages of various of the cycles of operation are reviewed here by Mr. Clancy, engineer with Drayer-Hanson, Inc. . . . In concluding his article, the author says that the reversible cycle refrigeration system is ideal, in most localities, for modern, well constructed buildings where year 'round conditioning is required, and that first cost need not be greater than the total cost of separate refrigeration plants and combustion heating plants designed to achieve the same objective.**

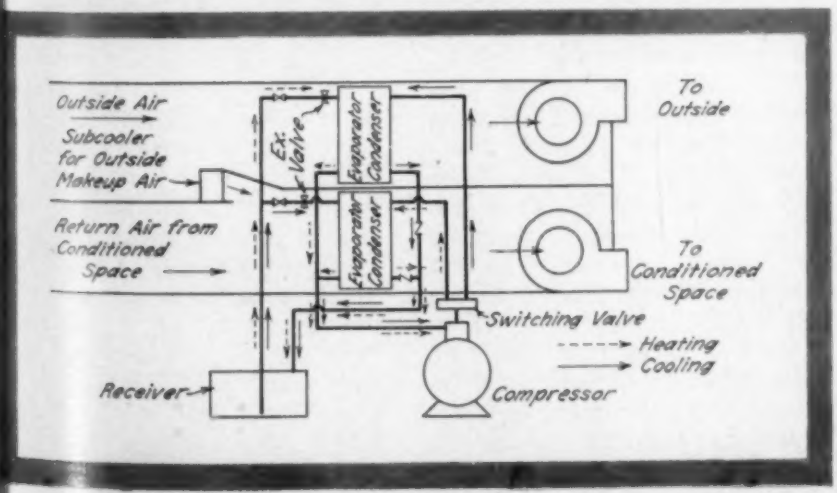
Factory built, self contained units are quite possible and advisable in sizes up to 15 hp and such units should be designed so that they can be more or less universally adaptable, at least for a given large section of the country.

Plants from 15 to 50 hp will in all probability be custom built for some years to come, but the design of this size should be somewhat standardized to avoid excessive engineering and development cost on each project. Larger projects or unusual projects should be carefully designed and constructed for the conditions and locality in which the system is to be used.

It is not impossible that hot water heating could be added in conjunction with a reversed cycle system, using another heat pump to lift up the condensing temperature of the air conditioning system to the hot water temperature. The value of this is questionable.

The reversible cycle system seems to be in most cases applicable only to projects wherein both summer cooling and winter heating would be required. At the present these systems cannot be expected to compete in first cost to systems of conventional combustion heating, and no cooling.

**Fig. 5—In this system, the primary tube circuits are duplicated, but the secondary surface is common to both circuits**




### Application of Reverse Cycle

Their use seems to be limited to more or less substantial modern buildings which require year around air conditioning. Special attention should be given to ducts, air distribution, and insulation.

When perfect year around air conditioning is required, especially for modern, well constructed buildings, the reversible cycle refrigerating system is, in most localities, ideally suited, it is the author's opinion.

Smaller size systems can be built to two or three standardized schemes, one which would be suitable for almost any climate which requires both summer cooling and winter heating.

In most localities the cost of heating with electricity by a reversed cycle system will not exceed the cost of heating with gas.

The first cost need not be greater than the total cost of two plants, one for refrigeration and one for combustion heating, which would be necessary to approach the results obtainable with a reversed cycle system. Furthermore, the one reversible cycle plant is inherently simple and reliable.

The reversible cycle system is a very desirable power load which should eventually result in still lower power rates and consequently lower operating costs.

A sufficient number of such systems have been built and operated to demonstrate their possibilities. In fact, the development can be regarded as now being beyond the experimental stage.

# HOW SHOULD PIPE WALL THICKNESS BE FIGURED?

**WHEN ENGINEERS** gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." We follow this custom in these columns, which provide an opportunity for readers to comment on articles published in HPAC; discuss other topics of interest to heating, piping, and air conditioning engineers and contractors; ask questions of authors; etc.

THE EDITOR—In an article entitled Pipe Wall Thicknesses for High Temperature Service Aren't Unduly Conservative, published in the May issue of HPAC, Arthur McCutchan disagrees with some of the statements made by the present writer in the article Pipe Wall Thickness Based on Total Combined Stress, which appeared in the March HPAC.

The writer is of the opinion that the critical stress in any structure is that stress which may induce failure — be it bending, shear, bursting, or any other stress. In a structure where all of these stresses exist, the combined stress is more likely to be critical.

When considering bursting stress alone, all of the factors entering into the formulas are well known, the formulas have been well proved, and results are accurate. Why a high factor of safety on bursting is so necessary is hard to visualize —other than the fact that this stress exists throughout the entire pipe line and will, therefore, exist at points of high bending stress and so aggravate the total combined stress.

The writer has never heard of a pipe failure from bursting. In 1940, at a conference on pipe wall thickness, the statement was made that the Navy had never had a steel steam pipe failure due to bursting. It would be surprising if one occurred with the safety factors provided. If a failure did occur, it would more likely be caused by the high transverse bending stresses which occur but are not usually calculated. This condition led Professor Hovgaard (2b)* to recommend a factor of safety of 6.0 on bursting; not necessarily because of bursting stress, but to allow for not calculating transverse stresses.

### Excessive Bending Moments

Mr. McCutchan has previously (4a) stated, "It is only when excessive bending moments result in leakage of bolted joints, or excessive thrusts or moments displace anchors or cause misalignment of equipment, that there is any untoward manisfestation of lack of flexibility . . . . The writer's observation of the disturbing effect of bending moments on bolted flanged joints is at variance with the reassuring conclusions reached by the authors . . . Actual experience . . . has indicated that even small bending moments can cause leakage of an otherwise satisfactory joint." Difficulties due to excessive bending moments and thrusts are a form of failure of the piping system and are definitely within the scope of any discussion of pipe wall thickness, since excessive thickness is one of the direct causes of the excessive bending moments and thrusts producing leaky joints and misalignment of equipment.

*See bibliography at end of this discussion.

## "OPEN FOR DISCUSSION"

To quote further on this subject, W. H. Shipman (1) has stated, "Excessive bending moments at joints are more likely to cause trouble than excessive stress in pipe walls. This is witnessed by the fact that failures of pipe walls are rare, while joints leak by the thousands, every new power plant having some leaky joints until the pipe has set."

The writer's use of the term factor of safety is exactly the same as that used by Professor Hovgaard (4b), "..... it seems safer and more rational to relate this factor (hoop stress) to the yield point, which determines incipient breakdown. It is of interest to note that Lloyds' rules, for instance, prescribe a thickness of pipe wall, which including the additional increment of 0.12 in. gives a factor of safety of about 7.0 relative to a yield point at 500 F of 27,000 psi."

It is true that the ASA standards do not vary over as wide a range of factors of safety as the writer stated in his original article; it must be recognized, however, that the writer was speaking of all of the regulatory bodies and was attempting to include also the variations of the American Bureau of Shipping and the Coast Guard. It is interesting to note that while all of these standards provide a relatively large factor of safety on yield strength at room temperatures, they do not reduce the allowable stress in the same proportion as the reduction in yield strength for higher temperatures; therefore, the factors of safety on yield strength at higher temperatures are reduced. To the writer, this has some of the earmarks of a means of evading the main point at issue. Since to provide the same factor of safety at all conditions would produce excessive thicknesses, the factor of safety is reduced by changing the terminology. It is something like the designer who calculates a stress by one formula and finds that the answer is too great; he then changes the formula to get a reduced answer.

The application of this principle is seen in the change from the use of the Barlow formula to the thick wall cylinder or Lamé formula for higher pressures. It is acknowledged that the Barlow formula is overly conservative (3a) for higher pressures, and so the allowable stresses are increased and the use of the Lamé formula is permitted, thereby reducing the factor of safety. It seems much more logical to the writer to revise the basis of calculation to a principle which combines all of the factors which tend to produce failure and apply a single factor of safety. This would appear to be in accord with the suggestions of W. W. Smith (2a) and A. E. R. deJonge (4c) who said, "..... the fixing of stress limits can only be a very rough approximation which of necessity must prove to be highly

controversial. The actual approach to the subject obviously is in investigating all of the different factors separately and more carefully than has hitherto been done, to fix for each one the limits within which theory and measured results agree, and then to compound these limit factors into a common factor."

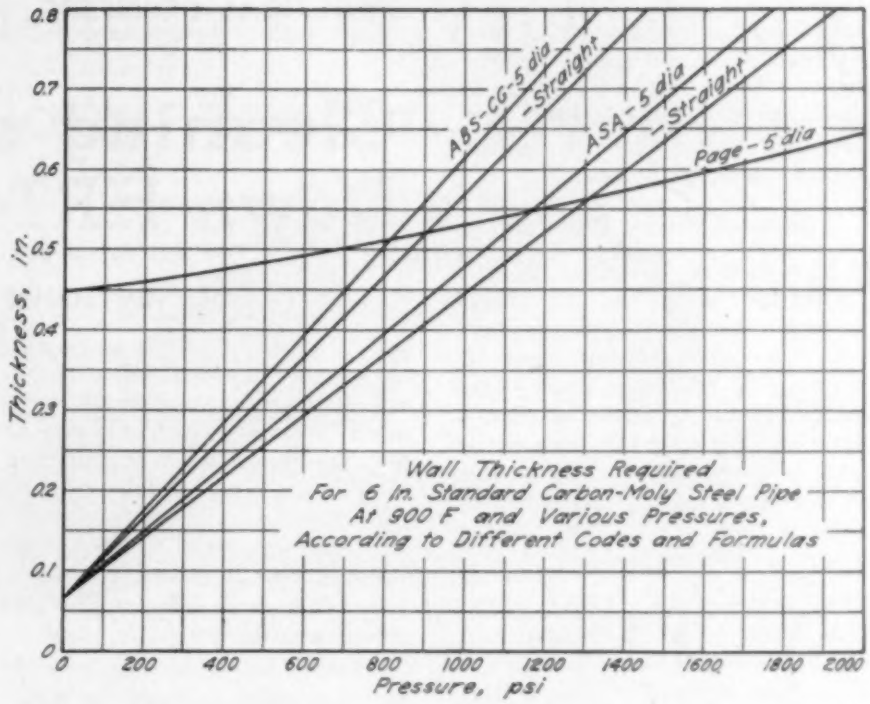
### Wall Thickness on Combined Stress Basis

In the original article it was the writer's intention to present simply a formula which permitted the selection of the pipe wall thickness on the basis of combined stress. As stated therein, the curves of Fig. 4 were for the purpose of illustrating the use of the formula and not necessarily the thicknesses the writer would recommend. The factors of safety selected were given as being representative of present practice which would account for the fact that the thicknesses arrived at by the writer check reasonably well with those of the American Standards Association code.

It is possible to use creep stress with this formula by means of the method indicated in the original article, where it was stated, "It may be desirable to base the allowable stress on proportional limit or creep stress. In any event, an allowable longitudinal bending stress must be selected and the value so selected is to be considered ⅔ of this yield strength value." This would still not preclude the use of a formula for combined stress in the selection of the thickness.

The writer's suggestion that the nearest larger commercial thickness be used to take care of thinning out of the pipe in bending was on the basis that a standard size of pipe would be used. If, however, the pipe wall is to be ordered for special thicknesses then no additional allowance should be necessary to allow for thinning out if the thickness is taken from the suggested formula.

The writer's comment that the present rules did not in some instances provide sufficient thickness can best be illustrated by the accompanying graph, which shows the thickness required by the writer's formula, the Coast Guard, ABS, and ASA codes for 6 in. standard pipe of carbon-moly steel




at 900 F and varying pressures. It can be seen that the thickness provided by the present codes is increased for pressure but does not provide sufficient thickness at the lower pressures to take care of the bending moments which occur with the presently accepted stress allowances for bending. This condition would be most noticeable in the case of a reheat installation where the pressure-temperature relationship might be 500 psi, 900 F.

### Corrosion Allowance

The criticism directed by the writer toward the corrosion allowance was intended also to criticize the 25 per cent difference in allowable working stress permitted between section 3 of the Code for Pressure Piping, covering oil systems, and section 1 covering power piping. The writer is still of the opinion that it is neither rational nor logical to use lesser thicknesses for oil refinery piping (which Mr. McCutchan states are entirely adequate for the service), than is used for power piping carrying either oil or steam at the same pressure and temperature. The oil refinery piping carries sulphur compounds and other highly corrosive elements, while the oil in power plants has been refined and the corrosive elements—so far as possible—eliminated. Further, in some instances velocities permitted in oil refineries run as high as 30 fps (sometimes even higher), while velocities in oil piping in power plants are held to within the order of 10 fps or less and even gas velocities in power piping only run in the order of 150 fps. The steam in power piping is produced from deaerated and chemically treated water. Certainly, if the thicknesses provided by section 3 of the code for oil refinery piping are adequate for that service, there is even more justification for believing that the thicknesses required for power piping are excessive.

### Cold Springing

The writer's meaning in connection with permanent set is the same as indicated by A. M. Wahl (1a), "It is not surprising to the writer that pipe bends so often undergo permanent set when placed in service . . . . This permanent set may annihilate the effect of cold springing, allowing excessively high reactions to be set up on turbines, anchors, etc."

The writer has not endeavored to discuss the question of cold springing, relaxation, or the proper allowances for these. On board ship their value is somewhat doubtful. The writer can seldom recall seeing a straight length of pipe of more than 6 or 8 ft in length. With the short lengths of straight pipe, the large number of bends and cross-connections in these systems (usually in three planes), it is possible

to introduce more severe stresses by cold springing than would exist without it. In industrial applications where longer lengths of straight pipe may be involved, definite advantage may be gained through cold springing.

### Based on Simple Principle

The formula prepared by the writer is based on the simple principle that the "one-horse shay" was an excellent design, since after running a hundred years to the day, it all fell to pieces at once.—OTIS W. PAGE, chief, engineering plan approval, New Orleans construction office, U.S. Maritime Commission.

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1) Transactions, ASME, 1929, FSP-51-52, by W. H. Shipman.

a) Discussion by A. M. Wahl.

2) Transactions, ASNA & ME, 1939, by Baggerud and Jernstrom.

a) Discussion by W. W. Smith.

b) Discussion by Professor Wm. Hovgaard.

3) Code for Pressure Piping, Heating, Piping & Air Conditioning, January 1942—August 1942.

a) Sabin Crocker, Heating, Piping & Air Conditioning, January 1942.

4) Transactions, ASME, Vol. 62, No. 5, July 1940, by Rossheim and Markl.

a) Discussion by A. McCutchan.

b) Discussion by Professor Wm. Hovgaard.

c) Discussion by A. E. R. de-Jonge.


## CONSTRUCTION . . . . INDUSTRY OR RACKET?

THE EDITOR—Just a word to say that I think Lester T. Avery's article on the construction industry, which appeared in the April issue of Heating, Piping & Air Conditioning, is the most enlightening article of its nature that I have seen in a long time.

### Laymen Should Read

Is there any way that you could have this article put in Life, Time, Newsweek or some other source where laymen could have an opportunity to benefit from it?—GEORGE PARKMAN, director, building construction and maintenance, Westinghouse Electric Corp.

***PRACTICAL POINTERS***

# Cleaning and Blowing Down HRT Type Boiler

**By JOHN G. CRONIN**

THE HRT type of boiler should not be blown down with the overnight pressure from the banked fires the first thing in the morning because the mud has all settled on fire sheets during the night and only the sediment near the blowoff will pass out. Wait until the mud has been stirred up by rapid circulation from the fire.

Allow to cool as much as possible before draining to wash. Use washout hose through top manhole first with lower plate on to prevent water splashing out into front end and leaking down into firebrick. Then wash thoroughly through front manhole and scrape out any loose scale which will not pass out blowoff pipe.

Wrap old rag around washout nozzle for packing and insert in lower opening of combination pipe cross and give full stream. This will clean pipe of any loose scale. Hold soft ball over opening in blowoff cross and put about 3 in. of water in boiler with hose. Withdraw ball and large flow of water will flush out pipe and bend.

Header drain pipe at back of boilers needs regular attention. Mud and sediment will collect around stop valve and swing check valve and interfere with free opening of this check valve which has only a slight differential pressure to open it at any time.

Examine boiler and blowoff pipe for signs of active pitting. Fill boiler with all openings for escape of air tightly closed in order that an air cushion will form in boiler as pressure is built up by city water feed. Check carefully for any leaks around blowoff flange, pipe, riveted seams, ends of tubes, and rivets in heads securing through stayrods.

Put in compound to prevent pitting and raise steam as soon as possible to thoroughly circulate and spread compound over all water heating surfaces.

A boiler closed and filled before opening of school in fall for rubbish burning, is damaged if raw water is intermittently heated for weeks before steam is raised for regular heating.

When adding compound to make up for that lost in blowing down, be certain the fresh compound is actually fed into the boiler needing it. Pouring compound into receiving tank with two or more boilers in service will allow one boiler to get more than enough and another boiler none.

Open boilers and dry out as soon as possible when not needed in spring. Make sure the discharge end of make up water feed pipe in receiving tank is well below the surface of water as an aid in preventing boiler corrosion.

Do not allow fireman to throw fire doors wide open at close of school to facilitate banking; this does not help brickwork and is hard on tube ends. — *Reprinted from Scotty-Grams by permission of John Howatt, business manager and chief engineer, Chicago Board of Education, and a member of HPAC's board of consulting and contributing editors.*

## COPPER TUBE AND PIPE STANDARD

Printed copies of Simplified Practice Recommendation R217-46, Copper Water Tube and Copper and Brass Pipe, are now available, according to an announcement of the Division of Simplified Practice of the National Bureau of Standards. The recommendation covers copper water tube and copper and brass pipe intended for plumbing uses.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 5 cents each.

# Airplane Heating and Ventilating Involves Many Special Problems

***Maurice Martin, Senior Research Engineer, Republic Aviation Corp., Stresses Importance of Passenger Comfort and Safety***

IN THE DECADE before the war tremendous strides were made in all phases of aircraft design. Though there has been very little design and construction of planes for commercial purposes during the last four years, the rapid pace and expansion required by the war effort have resulted in technical achievements far beyond anything previously dreamed of within the industry. The airplane, as a commercial vehicle, has outgrown its infancy and will compete strenuously with other means of transportation. Speed has always been its big talking point because, in this fast moving era, travel time is wasted.

Comfort of passengers, however, is of utmost importance; very little time could be saved by a long distance, high speed flight of 12 hr duration requiring about 6 hr for mental and physical recuperation. In order to win the appeal of wider circles and to prosper, commercial air traffic has to consider the comfort of paying passengers, even at the expense of valuable weight" (2).† There are many phases of comfort that concern the designer, such as soundproofing, galley and lavatory facilities, and sleeping accommodations. Our interest here is confined to some of the problems with which the heating and ventilating engineer is concerned. With the trend to higher altitude flight, this includes defogging, defrosting, and pressurized cabin problems.

### Physiological Considerations

In dealing with high altitude flight, the problem is more than one of comfort alone but is one of maintenance of life and health. Low temperatures, low pressures, and lack of oxygen must be overcome by the heating and ventilating system in a large passenger plane. The need for oxygen and for reasonable temperatures and pressures seems rather obvious but can only be dealt with intelligently when approached from a physiological viewpoint.

Temperature falls with altitude at a rate of 3.6 F per thousand feet until the stratosphere, where the temperature was at one time considered constant at —67 F, is reached. Recently, it has been found that temperature continues to decrease to —85 F, and the designer would do well to design for —90 or —100 F.

Low temperature is one of the sources of danger in flight at high altitudes. The body can make up for a small lack of heat by means of natural shivering but this is not even sufficient at medium altitudes. "Shivering is an additional cause of danger to the pilot and passengers since the involuntary exercise increases metabolism, requiring additional oxygen which is not readily available at high altitudes. This may create an oxygen lack where, under condition of rest, no lack would be apparent. The fact that cold impedes the circulation and reduces the supply of oxygen to the tissues accounts for the fact that the effects of cold are very similar to those of oxygen lack. Electrically heated suits are, of course, out of the question for passenger flights, and the heated, closed cabin is the solution" (1).

The percentage of oxygen in the air is the same at 10 miles altitude as it is at sea level, approximately 21 per cent. The proper approach to the problem, however, is from the viewpoint of partial pressures. At sea level the pressure of the air is 760 mm and the partial pressure of oxygen is 160 mm, while at 19,250 ft the total air pressure is 362 mm and the partial pressure of the oxygen is 76 mm. In other words, the effect of breathing air at 19,000 ft is about the same as breathing the air at sea level with half the oxygen removed.

The process of breathing is a mechanical one in which gases move from an area of high pressure to one of low pressure. The move-

† Numbers in parentheses refer to the bibliography.

ments of the chest muscles and diaphragm merely have the effect of changing the pressure within the lung cavity. At sea level the partial pressure of oxygen in the tissues is 50 mm. The difference between this and the 160 mm in the air is enough to cause the oxygen to flow to the tissues over various hurdles or resistances to flow. The carbon dioxide, which has a greater partial pressure in the blood than in the lungs, moves in the opposite direction. After exhaling, the lungs still contain about 6 to 7 pints of air, called alveolar air. The newly inhaled air mixes with this, and the resultant pressure of oxygen in the lungs is equal to 100 mm. This partial pressure also decreases with altitude and at 15,000 ft it is 37 mm. The partial pressure in the blood does not fall off as rapidly because much of it is in chemical combination with red corpuscle pigment. While at sea level the blood carries 96 per cent of its capacity, at 20,000 ft this drops off to about 61 per cent.

Breathing pure oxygen would help up to certain altitudes. If one were to breathe pure oxygen at 25,000 ft, the partial pressure of alveolar air in the lungs would be about 185 mm; at 30,000 ft, 130 mm; and at 33,000 ft, about 105 mm or close to that at sea level. Above this, breathing pure oxygen does not help completely and at 45,000 ft, unconsciousness may occur (1).

Rapid decrease in pressure experienced in ascending to high altitude results in aerombolism or aerial bends. Boiling, or changing state from liquid to gas, can be accomplished by lowering pressure as well as by increasing temperature. Under normal conditions, nitrogen, while useless to the body, is forced into the blood stream by the higher pressure in the lungs and dissolves in the blood, as does $CO_2$. Rapid ascent and decrease in pressure releases these gases from the blood and they appear as minute bubbles that merge into bubbles of larger size. These bubbles may block the circulation, press on the nerves, and otherwise interfere with normal functioning of the body. If ascent is slow enough, the lungs could get rid of the nitrogen, but the rate of climb would have to be 80 fpm. Below 30,000 ft, there is not much danger of aerombolism, but long flight above this altitude produces serious effects. The pressurized cabin offers a solution of this difficulty as the change in pressure in descent or ascent can be artificially limited by the pressure control mechanism.

At lower altitudes, the difficulties which most passengers experience in keeping the pressure in their middle ears equalized has necessitated the limiting of commercial air transports to a rate of climb of 300 fpm or less. "This rate of ascent or descent is not economical in aircraft operation and is one of the more important advantages for the pressure cabin, in that the amount of barometric change with ascent to high altitude can be limited" (12).

**COMFORT OF airplane passengers is of the utmost importance; very little time could be saved, for example, by a long distance, high speed flight of 12 hours' duration requiring about six hours for mental and physical recuperation. Thus, commercial air traffic must consider the comfort of paying passengers even at the expense of valuable weight. In dealing with high altitude flight, the problem is more than one of comfort alone, but is one of maintenance of life and health as well. . . . The author reviews here some of the special problems met in heating and ventilating commercial planes. This article is based on the thesis he submitted in partial fulfillment of the requirements for the degree of master of aeronautical engineering, College of Engineering, New York University**

The usual requirements of a good air conditioning system on the ground include comfortable temperature, proper air distribution, cleanliness of air, and humidity control. For the airplane we must add the necessity of pressurization. The control of humidity in pressure cabin aircraft, however, presents a formidable problem because of the fact that the human requirement and the technical requirements are diametrically opposed. For human comfort, a relative humidity of 25 to 50 per cent is desirable. If such a humidity is maintained in a pressure cabin, however, all of the cabin windows will frost over and interfere with outside vision. Technically, the dew-point of the cabin air must be below the inside surface temperature of the cabin window to prevent frost. Naturally, the lower the relative humidity the lower the dew point at cabin temperature.

### Quantity of Air Supply

Though each problem is interrelated with the others, as a beginning to the development of design procedure, a preliminary estimate of the amount of outdoor air required must be made. A. A. Arnhym has concisely summed up the requirements of the ventilating system (3).

"The supplied air must furnish sufficient oxygen for respiratory purposes to the absolute ceiling of the airplane and must be reasonably clean and free of dust, bacteria, etc.

"It must provide constant circulation, not rapid enough to cause harmful drafts, yet capable of removing smoke and objectionable odors which increase the tendency to airsickness.

"It must keep the percentage of $CO_2$ in the air down to a desirable level.

"It must have sufficient but not too much cooling power to insure the comfortable maintenance of normal body temperature without undue restraint or demand upon bodily activities.

"It must provide for proper distribution of both humidity and heat.

"If air and heat supply are combined, with air being the heat transfer medium, air must be introduced in sufficient quantities to prevent the need for high inlet temperatures.

"At high altitudes, it must aid in maintaining a safe pressure around the body."

The most usual amount of outdoor air introduced for an installation similar to an airplane in conventional ventilation design

about 20 to 30 cfm per person (4). Introducing this large quantity of outdoor air at high altitudes, however, would result in large sizes of heating equipment as well as very low humidities. The humidity problem is complex in that the comfort requirement requires humidities too high for proper defrosting.

The Army Air Corps determined at Wright Field that 1 cfm per person is enough to keep the $CO_2$ content at a desired level, 5 cfm if the cabin air is recirculated will be fairly comfortable, and 10 cfm will take care of comfort and adequate ventilation (5). Ten cfm is also approved as a minimum in common ventilation practice (4). This should be considered on a poundage basis for all altitudes, due to change in density with altitude. Ten cfm of standard air, density 0.075 lb per cu ft, is equal to 45 lb per hr. This small amount of outdoor air supply would require a proportionately large amount of recirculation. Although some authorities recommend no recirculation at all (6), the author believes that it would be most economical to use some "revitalizing" agent or method to remove tobacco, food and other stagnating odors from the recirculated air. At lower altitudes, greater amounts of outdoor air may be introduced and less recirculation resorted to as the humidity and heat problem would not exist to as great an extent as at high altitude.

The amount of air to be recirculated will also depend on the heat losses through the shell of the plane to the outside air. A high delivery temperature is particularly undesirable for comfortable conditions. Of course, the larger the mass of air used to overcome the heat transmission losses, the lower the delivery temperature, and the designer will have to choose a quantity to be recirculated that will give reasonably low delivery temperatures without too rapid a rate of air change in the cabin. A maximum rate of air change in the cabin would be one change per minute, and an average about one change in two minutes, a rate which should not be exceeded unless unusually high delivery temperatures would result. The maximum temperature differential of delivered air above cabin air should be about 90 F. If higher temperatures must be used, extreme care should be exercised to prevent the discharge of air directly toward occupied areas.

### Heat Transmission Coefficient

The calculation of heat transmission through various sections of the shell of the plane is a straightforward one and involves the determination of an overall heat transfer coefficient for each type of section—uninsulated portions, insulated portions, glass area, etc. The overall coefficient of heat transfer for any section is the Btu per hr transmitted through the section per sq ft of exposed surface per F temperature difference between the outside air and the design cabin temperature.

The general relationship connecting the overall heat transfer coefficient and the particular coefficients of the component material of a particular section is:

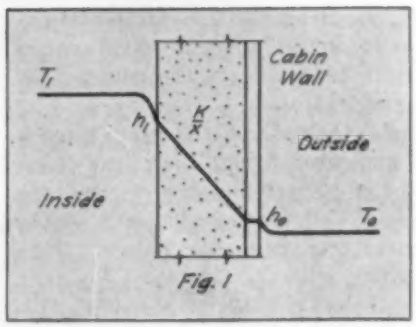


Fig. 1

$$\frac{1}{U} = \frac{1}{h_i} + \frac{1}{h_o} + \frac{1}{C} \ldots + \frac{x_a}{k_a} + \frac{x_b}{k_b} + \frac{x_c}{k_c} \ldots$$

where $U$ = overall heat transfer coefficient, Btu per hr per sq ft per F; $h_i$ = inside surface heat transfer coefficient; $h_o$ = outside surface heat transfer coefficient; $x$ = thickness of particular insulating material layer; $k$ = thermal conductivity of particular insulating layer in Btu per hr per sq ft per F per unit thickness; and $C$ = conductance of air space.

A simple construction is shown in Fig. 1.

$$U = \frac{1}{(1/h_o) + (k/x) + (1/h_i)}$$

The resistance of the metal shell is negligible compared to the others. For this formula, the conductivity of the insulation can be found from manufacturers' catalogs. The inside surface coefficient is taken as 1.65 if the cabin conditions can be considered as "still air" (4). For cases where there is a known value of air motion, one of the formulas mentioned below for outside air might be used. The outside surface coefficient at the high velocities encountered is very large (i.e., small resistance) so that an exact value is really not necessary. For certain calculations, however, especially defrosting, a rather exact value would be desirable.

Of all formulas investigated, there are two that seem most reasonable.

$$h_c = 0.050K\left(\frac{\rho V}{\mu}\right)^{a,m} + 1.65\,\sigma\,T_s/T$$

where $K$ = conductivity of air, Btu per hr per sq ft per F per ft; $\rho$ = density of air, lb per cu ft; $\sigma$ = standard altitude density ratio of air; $T$ = absolute temperature, F; $\mu$ = coefficient of viscosity of air lb per sec ft; $T_s$ = standard temperature at altitude (absolute); $V$ = velocity of air over the surface, ft per sec.

Any length factor is omitted on the formulator's premise that above

**Comfort of passengers is of utmost importance**

Photo courtesy PCA

a certain length this factor is unimportant. The second term on the right hand side of the equation is emperical.

Another source (8) gives a more complicated formula but one which is more exact and can be used for inside surface coefficients when there is definite air motion in the cabin.

For Reynolds' number $\frac{V_m l \rho}{\mu' g}$ less than 50,000, i.e., $V_m l < 16$ ft²/sec.

$$\frac{h}{3600\, c_p V_m \rho}(Pr)^{2/3} = 0.66\left(\frac{V_m l \rho}{\mu' g}\right)^{-1/2}$$

where $Pr$ = Prandtl modulus = $\frac{\mu' c_p g\,(3600)}{K}$, e.g., for air at 50 F, sea level:

$$h = 2.45\left(\frac{V_m \rho}{l}\right)^{0.5}$$

For Reynolds' number greater than 50,000, or for air at 50 F, $V_m l > 16$ ft²/sec.

$$\frac{h}{3600\, c_p V_m \rho}(Pr)^{2/3} = 0.036\left(\frac{V_m l \rho}{u' g}\right)^{-1/5}$$

e.g., for air at 50 F

$$h = 4.25\left(\frac{V_m \rho}{l^{0.25}}\right)^{0.8}$$

where $h$ = Btu per hr per sq ft per F; $V_m$ = velocity of main body of moving fluid in ft per sec; $\mu'$ = absolute viscosity, lb sec per sq ft; $l$ = length of surface measured parallel to the air stream, ft.

The coefficient 1.65 for inside surface films is an empirical one based on various types of building constructions (4). As an approximate value, it is also used for airplane design (7). A more exact value can be obtained from the above formula for low Reynolds' numbers when there is some air motion. For natural convection the following formula may be used:

$$h = 0.30\,\Delta t^{0.33}\left(\frac{\rho}{\rho_0}\right)^{1/3}$$

where $\Delta t$ = temperature difference, surface to air; $\rho$ = density of air at the arithmetic mean of plate temperature and ambient gas temperatures at the pressure of the ambient gas; $\rho_0$ = standard density of the air at 70 F, one atmosphere.

The surface transfer coefficient is the coefficient of a thin layer or film of air immediately adjacent to a surface. This coefficient has its effect when considering bare steel walls of the plane, but as the thickness of insulation or complexity of construction increases, the effect of the surface transfer coefficient drops off and the outside surface coefficient at appreciable velocities can be neglected in computing an overall coefficient. For certain calculations, however, especially defrosting, a rather exact value is desirable.

The calculation of the overall coefficients of aircraft structures based on theoretical concepts is extremely difficult. For example, no formulas for air space conductances in built-up curved sections are available. A great deal of research remains to be done to determine the proper coefficients to be used. Utilization of empirical data based on building construction experience is very approximate.

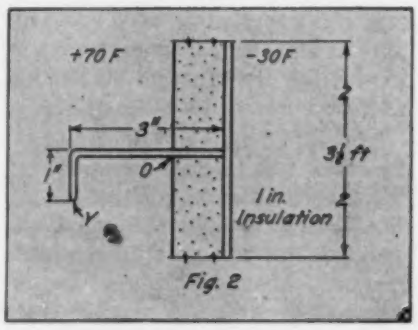


Fig. 2

It might be well to point out that no matter how well the plane wall is insulated, the insulation would be rendered almost ineffective if any fair amount of metal in direct contact with the shell of the plane were allowed to protrude through the insulation. In portions of the plane where shell stiffeners are uninsulated, calculations show that the exposed stiffeners more than double the heat transmitted through the structure.

If the stiffener spacing is 3½ ft, we take a typical section 1 ft high and 3½ ft wide, determine the transfer through this section in Btu per sq ft and divide by 3½ to determine $U$. Heat flows in parallel through the insulated section and through the stiffener and the total through the 3½ ft sq section is the sum of both.

The flow through the stiffener is computed as follows:

At high velocity, the resistance of the outside film coefficient is negligible. Therefore, the steel wall and, due to direct steel contact, the stiffener at point $O$, Fig. 2, will be —30 F. The stiffener is similar to any exposed bar fin for which McAdams (10) gives the formula:

$$\frac{(\Delta t)_m}{(\Delta t)_0} = \frac{\tan h\, a x_t}{a x_t}$$

where $\Delta t_0$ = temperature difference at base of fin, 100 F; $x_t$ = length of exposed fin = 3 in. = 0.25 ft; $a = \left(\frac{hb}{ks}\right)^{0.5}$

$h$ = surface transfer coefficient = 1.65 Btu per hr per sq ft per F; $b$ = exposed perimeter of cross section = 2 ft; $S$ = cross sectional area = 0.25 sq ft; $k$ = thermal conductivity = 117 Btu per hr per sq ft per F per ft; $(\Delta t_m)$ = temperature difference for entire fin.

$$a = \left(\frac{1.65 \times 2}{117 \times 0.25}\right)^{0.5} = 0.336$$

$$a x_t = 0.336 \times 0.25 = 0.084$$

$$\tan h\, a x_t = 0.0838$$

$$\Delta t_m = \frac{0.0838}{0.084} \times 100 = 99.8 \text{ F}$$

$Q_1$ (through stiffener) = $\Delta t_m \times 1.65 \times 2 \times 0.25 \times 1 = 82.3$

Neglecting the outside surface resistance, which is of no consequence, the coefficient for the panel itself would be

$$U' = \frac{1}{\frac{1}{1.65} + \frac{1}{0.24}} = 0.21$$

Thermal conductivity of the insulation used in this example = 0.24.

Heat flow through the panel in Btu per hr:

$$Q_2 = 0.21 \times 100 \times 3.5 = 73.5$$

$$Q = Q_1 + Q_2 = 155.8$$

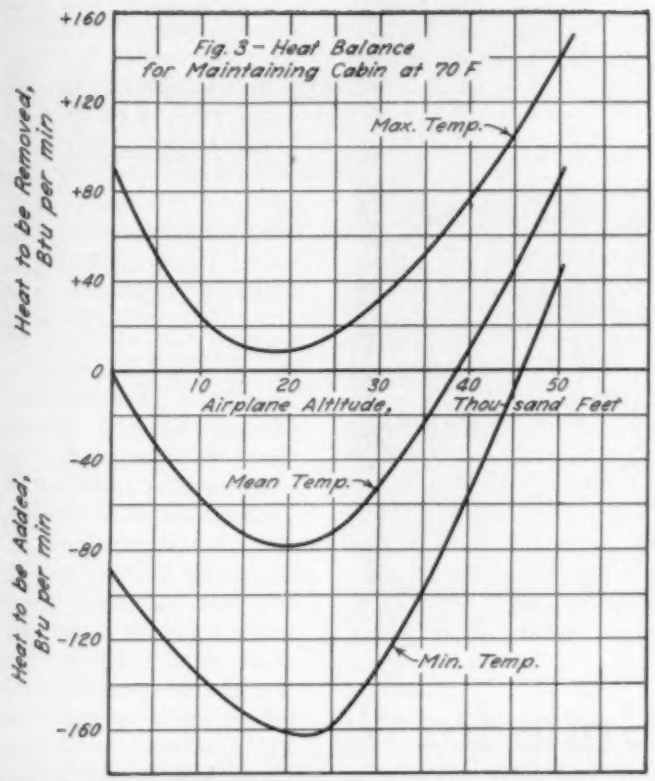
Overall coefficient:

$$U = \frac{Q_1 + Q_2}{3.5 \times 100} = 0.444$$

The exposed stiffener has more than doubled the heat transmitted through the structure.

The particular calculation seems to indicate that the same result would have been obtained by considering the stiffener as an additional area of uninsulated metal. However, the form indicated above should be used and would result in a different solution if a higher value of $h$ or lower $k$ would have been indicated by different conditions. It would be erroneous to assume that the stiffener represented additional exposed surface.

The proper type of insulation would therefore be one that covers the stiffeners also and eliminates as much metal "short circuiting" as possible. Of course, some means of attachment of the insulation to the shell of the plane is necessary, but phenolic fittings may be used and metallic circuits kept to a minimum.




After coefficients are determined for various sections of the plane, the heat loss is determined for the lowest outside temperature, this representing the maximum possible heat load. The maximum heat load might not occur at this condition because of the heat added by supercharging, but this maximum possible load should be considered in selection of the heater.

### Heat Balance

The temperature problem does not end with heating alone. The compression in the supercharger is practically adiabatic, resulting in an increase in the temperature of the air passing through. Since the compression ratio of the cabin supercharger increases with altitude, the temperature of the delivered air will also rise. The delivered air temperature will vary in accordance with the outside air temperature, necessitating a double set of heat balance calculations involving the maximum and minimum free air temperature conditions.

In a heat balance calculation the heat transmitted through the plane wall to or from the cabin is considered along with that added to the cabin by the supercharger. The latter is calculated from the formula $Q = 0.24\ w\ (t_d - 70)$, where $t_d$ = delivered air temperature from the supercharger and $w$ = lb per min of air delivered.

The complete calculation must be made for both extremes of temperature to determine the amount of heat to be added to or extracted from the cabin air. Heat would be added in a heater, i.e., the condenser of the steam heating system. Heat would be extracted in an aftercooler or heat exchanger with outside air, introduced by "ram" effect of the motion of the plane, used as the cooling medium.

In hot weather, prior to takeoff, when a transport plane is often held off at the end of the runway for as long as 15 min, mechanical cooling might be required. During flight at fairly low altitudes, with supercharger operating, cooling is usually required. This latter condition may be expected in the modern passenger transport.

A typical problem would be as follows (11): A small pressure cabin is supplied by a supercharger delivering 2.6 lb per min of air at altitudes up to 35,000 ft. Above 35,000 ft the delivery is as follows: 40,000 ft, 2.5 lb per min; 45,000 ft, 2.4 lb per min; 50,000 ft, 2.3 lb per min. The cabin walls are insulated with 0.50 in. of insulation having a conductivity of 0.24 and a double window installation is provided. There are 59.30 sq ft of exposed metal surface and 11.80 sq ft of window area through which heat loss will occur. If the outside air temperatures and supercharger air delivery temperatures were in accordance with Table 1, the curves resulting from the heat balance calculations for extreme limits would be as shown in Fig. 3.

**Table 1**

| Altitude | Lb Per Min Air Delivery | Outside Air Temp. Max. | Outside Air Temp. Min. | Delivered Air Temp. Max. | Delivered Air Temp. Min. |
|---|---|---|---|---|---|
| Sea level | 2.6 | 120 | 0 | 140 | 35 |
| 5000 | 2.6 | 90 | —18 | 121 | 20 |
| 10000 | 2.6 | 70 | —35 | 105 | 5 |
| 15000 | 2.6 | 50 | —50 | 120 | 5 |
| 20000 | 2.6 | 30 | —70 | 145 | 20 |
| 25000 | 2.6 | 10 | —90 | 182 | 50 |
| 30000 | 2.6 | 0 | —90 | 230 | 100 |
| 35000 | 2.6 | —20 | —90 | 285 | 155 |
| 40000 | 2.5 | —30 | —90 | 350 | 250 |
| 45000 | 2.4 | —30 | —90 | 415 | 300 |
| 50000 | 2.3 | —30 | —90 | 487 | 380 |

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QUESTION OF THE MONTH

# Should We Use Units for Heating a Greenhouse?

*FOLLOWING is a previous question from a reader, with a number of answers to the problem on which he requested information:*

We have a customer who has a large greenhouse in which he grows only tomatoes which are, of course, for marketing purposes. This greenhouse is heated with pipe coils, but the humidity in his greenhouse is so high that he is troubled greatly with leaf mold, which has caused at least 40 per cent reduction in production. We are of the opinion that this could be eliminated by using a unit heater instead of pipe coils, and would appreciate very much your suggestion.

We have proposed, in this particular instance, to furnish gas fired propeller type unit heaters, but the question has arisen, of course, as to whether the hot air from the heaters would be injurious to the tomatoes, as these tomatoes grow at least 6 ft high and this does not leave very much space above the tomatoes. Will the hot air coming from the heater be injurious to plants? —J. C. F.

## ADMIT OUTSIDE AIR TO KEEP HUMIDITY DOWN

Our experience in greenhouse heating is limited to the commonly accepted direct radiation type using either steam or forced hot water through radiators or pipe coils. We know of no installation in which unit heaters or forced circulation is used. It is our impression that it is desirable to keep air circulation down to a minimum.

Please bear in mind that the information which we offer is simply an opinion and is not based on authoritative data. We would imagine that any heating system which is based on circulation of air and the proper distribution of air for heating would not work out satisfactorily in a greenhouse because with growing plants the rapid air circulation would cause a drying out of the leaf surfaces—and then, too, distribution would be hampered because the plants would occupy more or less space in the greenhouse as they grow.

If anything, we would think that forced air would cause a higher humidity to be maintained in the space because of the fact that increased circulation would cause more moisture to be given off by the plants and from the ground surface.

We believe that the proper solution to this problem is to admit enough low moisture outside air into the room to dilute the moisture in the space and hold the proper humidity. This probably could be accomplished by natural means with an exhaust that leads from near the floor level out through the peak of the roof, and intake duct located near the ground level and extending upward and discharging into the space near the peak of the greenhouse. It would be preferable, however, to admit the air by forced means and temper it to approximately the temperature in the space before coming in contact with the plants.—H. W. H.

## USE DUCT SYSTEM WITH UNIT HEATERS

In heating greenhouses it is necessary that air velocity and temperature be kept constantly under control; otherwise, damage results to the growing plants. To overcome this, it is necessary to use a duct system in conjunction with the unit heaters. In a normal installation, the warmed air from the heater is carried along the peak of the roof in a metal duct. At each outlet on this duct an air diffuser is installed. The number of these outlets depends upon a calculated velocity and Btu loss.

The wiring on the unit heater itself should be changed from the standard wiring, so that a bonnetstat can be placed in the duct system to prevent air temperatures exceeding 115 to 125 F at the air outlets. In other words, this bonnet control would operate the fuel solenoid valve while the fan runs continuously during the heating cycle.

An installation of this type was made in a medium-sized private greenhouse several years ago and

ANSWERS TO PREVIOUS QUESTIONS

results were very good from the standpoint of continuous circulation of fresh air (some fresh air can be introduced into the duct system from the outside), and very reasonable operating costs. I cannot, however, guarantee that this type of heating would do away with the leaf mold mentioned—but this type of heating certainly reduces relative humidity to a considerable extent.—C. C. O.

### PROBLEM IS ONE OF VAPOR ABSORPTION AND REMOVAL

The method of providing heat to a greenhouse has very little to do with the humidity in the greenhouse. The humidity is the result of moisture given off from the plants themselves, and from the earth in which they are growing, and just as much humidity would be given off if the temperature were maintained at the same degree, whether the greenhouse were heated by hot water coils or by unit heaters, and the only way that the humidity can be reduced that we know of is to bring in some fresh air from outdoors, heat it in passing it through the unit heater, and allow it to escape through vents in the upper part of the greenhouse.

This warm air coming from outdoors will have extremely low humidity when it leaves the unit heater, and will absorb a great deal of moisture, but some provision must be made for that moisture laden air to escape if he wants to reduce his humidity.

The same thing could be accomplished by allowing air to enter the greenhouse beneath the benches on which the tomatoes grow, and venting it through the top. This cool air coming in would have great moisture capacity, and if properly heated, either by passing over the pipe coils, or by passing through a unit, it would reduce the humidity in the greenhouse.

I would be very much inclined to believe that a unit heater in a greenhouse would be apt to cause serious damage to the tomatoes in its immediate vicinity.

In other words, J.C.F.'s problem is one of vapor absorption and removal, and we know from past experience on dye houses, and other places where vast amounts of moisture are present and given off in the process, that the only way to get rid of it is to absorb it by introducing fresh air from outdoors and allowing moisture laden air to escape through vents in the top of the room, and the same remarks apply to a greenhouse.—A. C. B.

### HEATING COILS WITH PROPER FAN EQUIPMENT

Some years ago we furnished heating equipment for a commercial greenhouse used for growing tomatoes in water culture. The equipment was not of the unit heater type, but consisted of heating coils with proper fan equipment, which delivered heated fresh air into a series of underground ducts under the growing troughs.

Carbon dioxide gas was introduced into the air stream, and we understand that this, combined with the gentle air circulation set up in the greenhouse, proved very satisfactory.

We do not believe that unit heaters with high final temperature delivering the warm air on the plant vines would prove very successful. We believe that very low final air temperature must be maintained and that this air should be so introduced as to prevent excessive drying and shriveling of the vines. —T. R. P.

### DEPARTMENT OF AGRICULTURE ISSUED BULLETIN ON UNITS

Some years ago, the writer had considerable experience with the operation of unit heaters in greenhouses. As a matter of fact, the U. S. Department of Agriculture put out a bulletin on the use of unit heaters in greenhouses which can be obtained by writing to the Department of Agriculture. The exact title of this bulletin and serial number are not known to me at this time but I think if J.C.F merely mentioned that he desired information on the use of unit heaters in greenhouses this will bring forth a copy.

The results of tests made indicate the use of unit heaters would not displace completely the use of pipe coils in greenhouse work. However, as a supplement to coils and for use as booster heaters, the results were excellent. There was an increase in pollination rate for those greenhouse commodities in need of air circulation for good pollination. The greenhouse itself was

## WHAT CAUSES WATER TO LEAVE THIS BOILER?

As a subscriber to HPAC, and a member of the piping trade, I have a problem that I wish to submit; it is one that made its first appearance a year ago.

An installation has a high pressure fire tube boiler of the horizontal type and two-thirds back in the fire box are two 4 in. tubes that form an "X" and connect between the sides of the water section of the boiler some 8 in. above the mud rim (that is, the lower part of the "X"; the upper part is about a foot above that). I presume that this is a sort of a "booster," as it is in the direct path of the oil-fired flame and at the point of most intense heat. Now, when the flues become sooted slightly, the water has a tendency to leave the boiler and cannot be controlled as the encrustation increases, thus causing the operator to pull the fire, cool the boiler, and clean the flues.

I am of the opinion that the removal of this booster contraption and welding in plates on the water section involved will correct the situation as I am of the belief that the intense flame directly on these 4 in. pipes causes too rapid conversion of the water into vapor, or in other words blasts the water out of the boiler. This booster gets white hot.

Another boiler nearby and without this contraption operates nicely.

The connection out of the boiler in question is correctly sized and ties into a header of sufficient capacity, so that detail is out of the question.

We now have the opportunity to remedy this situation as the summer load can be taken care of by the nearby boiler.

I'd appreciate any information which would help us in solving this problem.—E. G. S.

*You are invited to submit an answer to E.G.S.'s boiler problem for publication in these pages. Suitable answers will be paid for at regular rates, with additional payment for sketches. You are also invited to submit a question for publication here.*

Acme

**"Our customer grows tomatoes for marketing"**

kept dryer and there was a better transmission of sun due to the unit heater tending to keep the moisture off the glass.

It would be the writer's opinion that in the case of leaf mold on tomato plants that proper use of the ventilating sash in the greenhouse would be helpful and it would also be his opinion that unit heaters used as described above would also help to correct this condition.

The placing of unit heaters in a greenhouse must be very carefully done, and as I remember it, the best results were obtained by placing the unit heaters near the blank wall either hung to blow down the ridge or at least in the aisle spaces so that there would be no direct impingement of the air on the plants. If there was no blank wall space in the greenhouse they should be so placed as to not impede the sun any more than possible. It would be the writer's opinion in the case of tomato plants that the heated air from the unit heater would have a bad effect on the tomato vines and on the tomatoes themselves if it were allowed to strike directly on them without first being diffused.

Incidentally all of the tests and operations that the writer is familiar with on the use of unit heaters was in connection with the use of steam or hot water and in no case were gas-fired unit heaters involved. It would seem that since steam or hot water is available for the coils that it would be more logical to use steam or hot water unit heaters. It would be the writer's supposition that gas-fired unit heaters might cause some difficulty due to the heat of the air stream and the possibility of escape of the products of combustion.—C. S. S.

## USE CARE IN DISCHARGING AIR FROM THE UNIT

In our opinion, the only practical way to reduce the humidity would be the use of unit heaters drawing in fresh air and it may be necessary to provide exhaust facilities unless leakage can be provided to take the place of the fresh air drawn through the unit heaters.

Care would have to be used in discharging the air from the unit heater. It should be discharged upward along the roof of the greenhouse in order not to injure the plants.

We have used such a system in connection with certain industrial operations where high humidities are created and it invariably has worked out satisfactorily.—R. T. T.

## BETTER AIR CIRCULATION SHOULD HELP

Presumably, the excessive high humidity and the mold growth occurs at the lower levels. Improvement in the humidity should be obtained with better circulation of the air. A unit heater with its provision for positive air circulation offers the facility for better diffusion and improved humidity.

We have no information as to the effect of the hot air currents upon the plants or intermittent hot air currents as might be obtained in this instance due to the limited space above the plants. There have been instances where tile ducts have been installed in greenhouses to increase the air circulation over the pipe coils to do away with objectionably high humidity in certain regions of the house.—D. N. C.

## CONTROL UNIT HEATER WITH A HUMIDISTAT

We do not see how simply changing the method of heating over from pipe coil to recirculating type unit heaters is going to do any good as far as reducing the humidity is concerned. Simply changing the type of heating system is not going to alter the humidity in the space.

In order to reduce the humidity, some means should be provided to introduce some dry outside air. Possibly this could be accomplished by simply installing an exhaust fan, and allowing an equivalent volume of make-up air to enter the greenhouse from some adjoining building. This, of course, would impose an additional load on the present pipe coils to heat up this incoming air, and if these pipe coils do not have a sufficient capacity for this purpose, then more positive results might be obtained by installing a unit heater connected to the outside and arranged so as to draw in air from the outside and heat it up to the proper temperature. The action of this unit heater could be controlled by a humidistat, so that it would operate only when the humidity went beyond a predetermined level.

While we have no definite experience in the application of unit heaters to such a greenhouse, we would be rather inclined to believe that blowing hot air over the plants would be injurious. Therefore if we were installing a unit heater to reduce the humidity in the manner described above, it would be our inclination to install it at the floor

line, so as to discharge the heated air brought in from the outside to reduce the humidity so it would not blow directly on the plants themselves.—J. S. K.

## MUST BE CAREFUL WITH AIR CIRCULATION

We have been in the unit heater business for a good many years, and as long as we can remember we have been very careful to avoid the use of unit heaters in greenhouses. The early installations which were made back in 1926 or thereabouts proved so destructive to the plants and flowers that it has left a very lasting impression on the writer. We would not knowingly permit anyone in our organization to put a unit heater in a greenhouse. Our experience at that time was to the effect that the products in the greenhouse wilted.

We don't wish to convey the thought that there has not been any progress in the application of unit heaters to greenhouses since that time; we have heard other people say that they have made successful installations, but our experience was so vivid back in 1926 that we would not take the chance again.

We think there is no question but what some air circulation in the greenhouse would help to alleviate the condition explained in J.F.'s letter. At the same time, the very air circulation which alleviates the condition is one of the factors which caused the bad results on the installation with which we are familiar. Whether tomato plants would be hardy enough to stand up we do not know. Insofar as our experience is concerned, it would be purely an experiment if one were to place unit heaters in a greenhouse of this type and take in a little fresh air from the outside, together with recirculated air and warm it up through the unit and create a positive circulation within the enclosure.—C. E. S.

## THREE IMPORTANT FACTORS IN GREENHOUSE HEATING

Before undertaking a botanical garden job, we made a very serious study of greenhouse heating, and the following remarks are based more on this survey than on any results that we might have obtained, because we have never been given a chance to put our theories in practice.

A) Pipe coils seem to be the standard method of heating greenhouses. We would attribute this to three reasons:

1) Lower air velocities and a film of warm air rising alongside the exposed surfaces.

2) Better distribution of the heat and less stratification.

3) The absence of any mechanical equipment that would have to be especially constructed to be waterproof against the spraying of the plants.

B) There is no doubt that a greenhouse could be successfully heated with unit heaters, but they would, of necessity, have to be the horizontal type, installed not too far from the floor, and be equipped with recirculating ducts. In the matter of air movement, we are under the impression that ferns are the only type of plant which might derive some advantage from a rapid air motion in the heated space. It is our belief that still air is ideal for the growth of fruits and vegetables.

C) Whether unit heaters or pipe coils are used, this will not increase or decrease the amount of humidity held in suspension in the air. It may, however, change the degree of concentration of moisture at certain levels, and there is no doubt that less stratification of the air, which would be caused by unit heaters mixing the air between the top of the unit heater and the floor space, might help matters a little between the level of the floor and the unit heaters providing, of course, recirculating ducts are installed.

D) If trouble is experienced with leaf mold and the cause of it is traced back to too heavy a concentration of moisture in the air, the answer to this problem, we believe, would be the installation of a complete ventilation system, which could remove a certain amount of humidity from the air and cut it down to say 25 per cent, but not below this figure. This might entail taking air in from the outside and washing it, but if this greenhouse is a very large one, the savings effected might warrant the expense. We are not advocating heating the greenhouse by ventilation. The pipe coils should remain in place, and if at all possible, be fed with steam under variable temperatures, so that heat will be on at all times and the whole body of air in the greenhouse kept in motion and a film of warm air maintained in front of the exposed surfaces continuously. Then the ventilation system should supply air at the temperature at which the greenhouse had to be maintained and would simply be used as a "blotter," which would absorb the surplus moisture.

We might conclude by saying that the three most important features of greenhouse heating are:

1) Continuous supply of heat through the greenhouse under variable rates so as to eliminate rapid warming and cooling shocks to the plants.

2) Low velocity air motion and a minimum of stratification.

3) Humidity controlled within a range of 10 per cent of the ideal conditions for the plants concerned.

—M. O.

## UNIT HEATERS HAVE FIVE ADVANTAGES

The following information on unit heaters was given in a Department of Agriculture circular No. 254, issued in December 1932, entitled Greenhouse Heating, by Arthur H. Senner.

"Unit heaters have been little used in greenhouses as yet. Some characteristics of unit heaters would seem to be ideal for this type of service, but no definite conclusions as to their practicability or their superiority over the ordinary type of radiation can be drawn until more tests have been made.

"Some of the chief advantages claimed for unit heaters in greenhouses are (1) relatively uniform temperature distribution, resulting from the effect of the fan in directing the heated air downward; (2) very little shading of crops, due to small, compact heating units with only a minimum of piping; (3) ease of control, through automatic control devices and varying the speed of the fan; (4) flexibility—the temperature can be raised or lowered quickly; and (5) a gentle air motion advantageous to crop growth provided by the circulation fan. One apparent disadvantage is the fact that continuity of operation depends upon the electric service."

This bulletin is available from the Superintendent of Documents, Washington, D. C., for 5c.

—N. E. B.

# The Air We Live In

AIR CONDITIONING in its true-sense is the promotion or encouragement of such air around the body of man as will aid his personal heat control equipment to function with maximum comfort. Thus, air conditioning deals with the moisture content of the air he breathes and that which touches his body. If the air is warm enough or cool enough and if it does not carry unpleasant odors, and if it has some oxygen and if it moves around the man enough to displace the too hot, too damp air against his skin, then it is pretty good air.

We try to accomplish these things in winter by warming the air, and in summer by extracting some of the heat from it. We try to bring the air into rooms rapidly enough to create a very gentle breeze. We try to remove from it some of the dust. We mix into it a proportion of new outside air so as to obtain lots of oxygen and by dilution to alleviate the odors that are generally associated with waste products of combustion. We may even filter out the smells that are so often associated with industrial processes.

Heating of air is comparatively easy, by bringing it into contact with surfaces warmer than the air, such as fire, a furnace, a steam heated pipe, a hot water pipe, or an electric wire. Cooling of air is not too hard. It can be accomplished by bringing the air in contact with surfaces cooler than the air—such as cold water, or as pipes chilled with a refrigerant that is changing state from a liquid to a gas and which therefore must absorb heat.

A considerable cooling effect for air that is relatively dry can be accomplished by evaporation of sprayed water—as in cooling towers or humidifiers. The air picks up low pressure steam from the water and, in so doing, due to the change of state of the water, becomes damp without becoming warmer, while the remaining water, from which part has been evaporated, gives up the heat necessary to accomplish this change of state and becomes somewhat cooler. This scheme works rather well in Arizona and in the dry climate of southern California east of the coast range of mountains. These mountains have always received on their cool tops the warm damp breezes from the Pacific ocean and have condensed much of the water vapor from the air—so that the great central valley east of the mountains has a dry climate and requires irrigation in order to be fruitful.

### Air Movement

Air movement in rooms is most effectively attained by means of fans and blowers. Air from outdoors, particularly where there is vegetation, usually is good air, since vegetation wishes to obtain the sort of gas that humans cast off and wishes to cast off the sort of gas that humans need. Dust can be removed by filters, and by an application of electronics whereby the dust particles, however small, are attracted by and arrested against magnetized metal plates.

The moisture content of the air can be increased in winter, if desired, by bringing the expanded warmed air through water sprays, or by mixing steam with it. When the air is humidified by water sprays, heat for the change of state of the water must be provided, and the fuel consumption required to heat a building rises in proportion to the amount of moisture artificially injected. The moisture content of the building air in summer may be reduced by chilling the entering air until it has contracted to a temperature cooler than its dew precipitating point, and then by warming the air to the desired temperature—say to that corresponding to 50 per cent relative humidity. This warming of the too-cool, too-damp air generally is accomplished by mixing with it some unheated air, though it is also frequently done by expanding the too-cool air by passing it around heated pipes.

Air that is too moist can be dried by bringing it into contact with common salt, though there are other spongelike and more efficient substances, such as silica gel, that "enjoy" collecting water vapor out of air.

### Control of Prime Importance

In all these processes of air conditioning, the control of the operations is of prime importance, and automatic means to do this are necessary to prevent waste of fuel and power and to keep the people from complaining. These automatic appliances are reliable and accurate. During the recent war many laboratories have been installed for manufacture of life and death materials and for research, particularly as to life, in which air temperature, relative humidity, freedom from dust, and definite movement have been controlled to exact specifications.

### Convection and Radiation

There are two basic principles that govern the comfort of the air spaces in which we live. They are convection and radiation.

Convection may be defined as heat transmission to air by passage of the air over an area that is dif-

SAM LEWIS' PAGE

ferent in temperature from that of the air.

A heat transmitter in a room, if placed against the ceiling, does a very poor job of creating convection air currents, since heated air is lighter in weight than cool air and the air around the ceiling radiator soon becomes very hot and cannot escape. Thus, a convection heat transmitter does best when near the floor.

A heat transmitter in a food refrigerator, if placed in the bottom of the cold chamber, similarly does a poor job—since the heavier cool air falls to the bottom and cannot escape unless one opens the door, while food will spoil in the upper part of the refrigerator. Thus refrigerators have cooling surfaces or ice compartments near their tops.

If one sits close to a window on a winter day he may feel the falling current of air along the glass. An interesting home-made anemometer may be formed with a little cardboard propeller balanced on the end of a vertical needle. Such a device will turn at a lively rate if held near the window, illustrating the down-going draft.

If the little anemometer is held above a warm radiator the propeller will spin rapidly, though the dust on the curtains and wall and ceiling above the radiator amply demonstrates to any housewife what convection air currents can accomplish in the way of dust transportation.

The ordinary cast iron heat transmitter, popularly called a radiator, warms a room largely by convection air currents bringing about a definite air circulation, upward around the heated surface and commensurately downward in some cooler part of the room. The hot exposed surface, however, also transmits radiant energy in all directions. Damp shoes placed on the floor under the radiator (even though in a relatively cool air stream) become warm. The wall behind the radiator and the furniture in front of it receive radiant energy and in turn cause their own convection air currents.

Enclosed heat transmitters, often made of copper tubes having projecting fins, are at present in popular use. The heated surfaces in these devices are relatively small, only from 2 to 4 in. high, always placed near the bottom of the metal enclosure. If these tubes are at steam temperature they cause very rapid convection air currents as a result of the considerable temperature difference between the entering air at, say, 70 deg and the steam at around 212 deg—an effective difference of 142 deg.

However, if these enclosed heat transmitters are heated by water at the usual temperature of 150 deg, the conventional hot water heating system temperature, the difference between the warm surface and the air drops to only 80 deg, and the speed of the convection air current falls off rapidly. For this reason, enclosed, room heating, finned type convectors are often ineffective when used on hot water heating systems unless the water is kept hot enough to approach steam temperatures.

There are many buildings in which some of the rooms have exposed cast iron radiators while other rooms have enclosed convectors. The occupants of such buildings are likely to be unhappy. If the great advantage of a wide temperature range obtainable with controlled hot water heating is to be gained, some other type of heat transmitters than finned tube convectors in the rooms is desirable.

**IN THIS regular feature, informal comment on heating, piping, and air conditioning matters is given by Samuel R. Lewis, consulting mechanical engineer, a member of HPAC's board of consulting and contributing editors. His remarks this month are taken from a popular Sunday afternoon lecture Mr. Lewis recently gave, which was one of a series sponsored by the Chicago Technical Societies Council at the Museum of Science and Industry in that city. Mr. Lewis spoke under the auspices of the Illinois chapter of the ASHVE.**

### Radiant Heat

Radiant heat comes with the light, from the sun. It comes to us through airless space until it reaches the thin layer of air that surrounds the earth. It passes through this thin air envelope without losing much heat and only after the rays warm the earth and the water and the buildings, is the heat transferred by convection to the air.

Long ago it was discovered that radiant heat—heat like that which is received by the body when exposed to direct sun light—is pretty good heat. It was also discovered that the body likes to be protected against too rapid heat loss, due to its attempt to emulate the sun by throwing off radiant energy. On this theory, an attempt is made to provide counter-radiation for enclosed spaces so that the heat lost by the body may be minimized. It was found that human comfort is promoted by minimizing convection air currents and by filling the room with radiant heat similar to that which comes from the sun.

This radiant method of heating gives comfort at a room temperature somewhat lower than can be achieved by convection currents of air. The energy may be supplied from surfaces warmer than air and these may be placed in ceilings, or walls, or in floors. Generally hot water at very moderate temperature is used for radiant heating, with a top temperature limit of about 135 deg even on a subzero day. One popular method is to install pipe coils at the ceiling, imbedded in the plaster so that the whole ceiling may reach an average temperature of 90 deg. Successful radiant heating can be achieved by pipes under the floor or furred into the walls and faced with plaster or metal or even with wood.

## CPA REDUCES AUTHORIZATIONS

To bring construction authorizations into balance with the supply of building materials, the CPA has ordered its field offices to reduce their dollar value of authorizations by two-thirds, for at least the next 45 days, it was announced May 30.

## URGES SIZE STANDARDS FOR BEARINGS

The nation's motor and machine manufacturers were urged recently to join a movement to standardize sizes of ball and roller bearings. Standardization, asserted S. F. Wollmar, executive vice-president of SKF Industries, Inc., would reduce overall costs, speed delivery of bearings to prime reconversion centers, aid young industries, and broaden American participation in world reconstruction.

"Ball and roller bearing manufacturers are now required to produce and stock as many as 40,000 sizes and makes of anti-friction bearings," Mr. Wollmar said. "Some of these products differ from others by the merest hair's breadth. If a uniform system of basic sizes were adopted, it might be possible to concentrate our capacity on turning out about 2000 sizes of bearings. These would meet almost every industrial need without any sacrifice of quality."

## SIMPLIFIED PRACTICE FOR REGULATING VALVES APPROVED

A proposed simplified practice recommendation, designed to establish a simplified list of pressure ratings and sizes for seven types of steel, iron, and bronze automatic regulating valves, has been approved for promulgation, according to an announcement by the National Bureau of Standards, division of simplified practice. The recommendation, identified as R219-46, Automatic Regulating Valves, became effective April 1.

## DETERMINING CARBON MONOXIDE IN AIR

A simplified method for determining the quantity of carbon monoxide in air, developed by Army Air Corps engineers, is described in a report released by the Office of the Publication Board, Department of Commerce, Washington 25, D. C.

The report may be ordered from OPB (PB-5121; photostat, $1.00; microfilm, 50 cents; 6 pages). Orders should be accompanied by check or money order, payable to Treasurer of the United States.

The method was developed to measure to 0.001 per cent accuracy the amount of carbon monoxide in aircraft cabins resulting from motor exhaust. In the analysis a spectrophotometer is used to measure the amount of iodine released in the carbon monoxide-iodine pentoxide reaction. Since the iodine released in the reaction is directly related to the amount of carbon monoxide in the air, the spectrophotometer can be calibrated to measure the percentage of carbon monoxide in the air sample.

## "MADAME X" AIR CONDITIONED

Mysterious "Madame X," recently revealed by the Navy Department as a super-secret proximity fuse for exploding shells near the target, was produced in large quantities at the RCA Victor plant in Camden, N. J., which made approximately one-quarter of the national total. Assembly of the fuses was carried on in a 50,000 sq ft area air conditioned by York Corp. to maintain less than 50 per cent relative humidity because undue moisture could make inoperative certain critical electrical and radio components of the fuse. In the final assembly, molten wax was poured over all open parts of the entire fuse unit.

## STANDARD ASSEMBLY LIST FOR CAST IRON RADIATORS

Based on a study which disclosed that 60 standard assemblies of cast iron radiators would take care of over 90 per cent of the total demand, a revised recommendation for simplified practice in regard to cast iron radiators has been issued by the National Bureau of Standards, division of simplified practice. Copies have been mailed to all interests for approval or comment.

The original recommendation was promulgated in 1940 and revised in 1941. Both of these issues listed large tube cast iron radiators only. In 1942 the WPB issued an order prohibiting the manufacture of large tube radiators, and the recommendation was again revised to bring it in line with the order which permitted only small tube radiators. The current proposal retains all but one of the sizes of small tube radiators. In addition, there has been added a stock assembly schedule of these radiators.

## SAYS VETERANS PASS UP BUILDING TRADES

PROF. HAROLD N. CHAMBERLAIN who directs Rensselaer Polytechnic Institute's educational and vocational advisement for the Veterans Administration in behalf of veterans who apply for training at college or lower levels under the G.I. bill of rights and the veterans public health law, says:

**"Of the first 1000 veterans receiving educational and vocational advisement, only seven per cent of those applying for training in the skilled trades were interested in the building trades. Why so few want to be carpenters, masons, painters, or plumbers is difficult to understand when the demand for them, already heavy, will be much heavier.**

"UNION REPRESENTATIVES have urged us to try to interest veterans in the building trades, where the number of apprentices has been small for years," he said. "We were told that in some building trades unions the average age of the members was 50 years, and that unless some younger men get in there soon wouldn't be enough left to train apprentices.

**"On the other hand," he continued, "so many veterans want to be radio mechanics and refrigeration and air conditioning mechanics that there is danger that these fields will be overcrowded. I'm afraid that this attraction is based too much upon merely the idea of getting into something new."**

## FORMULA FOR ABATING SMOKE

AT A RECENT meeting on smoke abatement, an engineer mentioned the following "formula" for reducing the amount of air pollution. He didn't know the original source of the quotation—but, anyhow, here it is:

**"If there were a smoke alarm in the office of the president or general manager of every plant, there would be no smoke problem."**

**Fuel conservation is always good business and is sound engineering.**

DATA SHEET

# PIPE SPECIFICATIONS

*By SABIN CROCKER, Senior Engineer—Mechanical, System Engineering Department, The Detroit Edison Co. Member of HPAC's Board of Consulting and Contributing Editors*

**Chemical compositions, physical properties, and allowable stresses for steel pipe used for power piping installations**

| ASTM Serial Designation | Type | Process[1] | Chemical Composition | | | | | | | | | Physical Properties[2] | | | | Allowable Stresses or S-Values, psi For Temperatures (Condensed)[3] of not to Exceed: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Carbon max % | Manganese % | Phosphorus max % | Sulphur max % | Silicon % | Nickel % | Chromium % | Molybdenum % | Tungsten or Vanadium % | Tensile Strength min psi | Yield Point min psi | Elongation, Basic Longitudinal In 8 in. min % | Elongation, Basic Longitudinal In 2 in. min % | 150 F | 450 F | 650 F | 750 F | 850 F | 950 F | 1000 F |
| A53 | *Welded[4] and Seamless Carbon-Steel Pipe Intended for[5] Bending, Coiling, Flanging (Except for Butt-Welded), and Other Special Purposes, and Suitable for Fusion Welding* | | | | | | | | | | | | | | | | | | | | | |
| | Butt-Welded | Acid-Bessemer | | | | | | | | | | 50 000 | 30 000 | 18 | | 6 750 | 5 950 | 5 400 | 4 700 | | | |
| | Lap-Welded | Acid-Bessemer | | | | | | | | | | 50 000 | 30 000 | 18 | | 9 400 | 8 150 | 7 300 | 6 250 | | | |
| | Lap-Welded | OH or EF | | | 0.06 | | | | | | | 45 000 | 25 000 | 20 | 30 | 9 400 | 8 150 | 7 300 | 6 250 | | | |
| | ERW Grade A | OH or EF | | | 0.045 | | | | | | | 48 000 | 30 000 | | 35 | None Listed | | | | | | |
| | ERW Grade B | OH or EF | | | 0.045 | | | | | | | 60 000 | 35 000 | | 30 | None Listed | | | | | | |
| | Seamless Grade A | Acid-Bessemer | | | 0.11 | | | | | | | 48 000 | 30 000 | | 35 | None Listed | | | | | | |
| | Seamless Grade A | OH or EF | | | 0.045 | | | | | | | 48 000 | 30 000 | | 35 | 12 000 | 10 360 | 9 600 | 8 250 | 5 850 | 2 600 | 1 350 |
| | Seamless Grade B | Acid-Bessemer | | | 0.11 | | | | | | | 60 000 | 30 000 | | 30 | None Listed | | | | | | |
| | Seamless Grade B | OH or EF | | | 0.045 | | | | | | | 60 000 | 30 000 | | 30 | 15 000 | 13 200 | 12 000 | 9 950 | 6 350 | 2 600 | 1 350 |
| A106 | *Seamless Carbon-Steel Pipe for High-Temperature Service With Supplementary Requirements where a Superior Grade of Pipe is Required[5]* | | | | | | | | | | | | | | | | | | | | | |
| | Seamless Grade A | OH or EF | 0.25 | 0.27 to 0.93 | 0.04 | 0.06 | | | | | | 48 000 | 30 000 | | 35 | 12 000 | 10 560 | 9 600 | 8 250 | 5 850 | 2 600 | 1 350 |
| | Seamless Grade A | Killed Silicon | 0.25 | 0.27 to 0.93 | 0.04 | 0.06 | 0.10 to 0.25 | | | | | 48 000 | 30 000 | | 35 | 12 000 | 10 560 | 9 600 | 8 700 | 6 850 | 3 900 | 2 000 |
| | Seamless Grade B | Acid-Bessemer | 0.25 | 0.29 to 1.06 | 0.11 | 0.06 | 0.10 min | | | | | 60 000 | 35 000 | | 30 | None Listed | | | | | | |
| | Seamless Grade B | OH or EF Silicon Killed | 0.35 | 0.29 to 1.06 | 0.04 | 0.06 | 0.10 min | | | | | 60 000 | 35 000 | | 30 | 15 000 | 13 200 | 12 000 | 10 490 | 7 400 | 3 800 | 2 000 |
| A120 | *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded[4] and Seamless Carbon-Steel Pipe For Ordinary Uses in Steam, Water, Gas, and Air Lines (Not Including Flanging, Close-Coiling or Bending* | | | | | | | | | | | | | | | | | | | | | |
| | Butt-Welded | AB or OH | | | | | | | | | | | | | | 6 500 | 5 700 | | | | | |
| | Lap-Welded | AB or OH | | | | | | | | | | | | | | 8 800 | 7 600 | | | | | |
| | Electric-Welded | AB, OH, or EF | | | | | | | | | | | | | | None Listed | | | | | | |
| | Seamless | AB, OH or EF | | | | | | | | | | | | | | 10 800 | 9 600 | | | | | |
| A135 | *Electric-Resistance-Welded Carbon-Steel Pipe[7] Intended for Conveying Liquid, Gas, or Vapor. Grade A only is Adapted for Flanging and Bending* | | | | | | | | | | | | | | | | | | | | | |
| | ERW Grade A | OH or EF | | | 0.045 | 0.060 | | | | | | 48 000 | 30 000 | | 35 | 10 200 | 8 950 | 8 150 | 7 000 | 4 950 | 2 200 | 1 150 |
| | ERW Grade B | OH or EF | | | 0.045 | 0.060 | | | | | | 60 000 | 35 000 | | 30 | 12 750 | 11 200 | 10 200 | 8 450 | 5 400 | 2 200 | 1 150 |
| A139 | *Electric-Fusion-Welded Carbon-Steel Pipe, Sizes 4 in. to 84 in. Inclusive Intended for Conveying Liquid, Gas, or Vapor. Grade A only is Adapted for Flanging and Bending* | | | | | | | | | | | | | | | | | | | | | |
| | EFW Grade A | OH or EF | | | 0.045 | 0.060 | | | | | | 48 000 | 30 000 | | 30 | 9 600 | 8 400 | | | | | |
| | EFW Grade B | OH or EF | | | 0.045 | 0.060 | | | | | | 60 000 | 35 000 | | 25 | 12 000 | 10 560 | | | | | |
| A155 | *Electric-Fusion-Welded Carbon-Steel Pipe for High-Temperature and High-Pressure Service Intended for Bending, Flanging, Corrugating, and Similar Forming Operations* | | | | | | | | | | | | | | | | | | | | | |
| | EFW Grade A | OH or EF | 0.15 to 0.17 | 0.35 to 0.60 | 0.05 Acid 0.04 Basic | 0.05 | 0.10 min. | | | | | 45 000 | 24 000 | | 33 | 10 100 | 8 900 | 8 100 | 7 550 | 5 150 | 2 350 | 1 200 |
| | EFW Grade B | OH or EF | 0.20 to 0.22 | 0.35 to 0.60 | 0.05 Acid 0.04 Basic | 0.05 | 0.10 min | | | | | 50 000 | 27 000 | | 30 | 11 250 | 9 900 | 9 000 | 8 100 | 5 400 | 2 350 | 1 200 |
| | EFW Grade C | OH or EF | 0.25 to 0.30 | 0.90 to 0.60 | 0.05 Acid 0.04 Basic | 0.05 | 0.10 min | | | | | 55 000 | 27 500 | | 27 | 12 400 | 10 900 | 9 900 | 8 550 | 5 700 | 2 350 | 1 200 |
| | EFW Grade A | OH or EF Silicon Killed[8] | 0.15 to 0.17 | 0.35 to 0.60 | 0.05 Acid 0.04 Basic | 0.05 | 0.10 to 0.25 | | | | | 45 000 | 24 000 | | 33 | 10 100 | 8 900 | 8 100 | 7 550 | 6 000 | 3 400 | 1 800 |
| | EFW Grade B | OH or EF Silicon Killed[8] | 0.20 to 0.22 | 0.35 to 0.60 | 0.05 Acid 0.04 Basic | 0.05 | 0.10 to 0.25 | | | | | 50 000 | 27 000 | | 30 | 11 250 | 9 900 | 9 000 | 8 100 | 6 250 | 3 400 | 1 800 |
| | EFW Grade C | OH or EF Silicon Killed[8] | 0.25 to 0.30 | 0.90 to 0.60 | 0.05 Acid 0.04 Basic | 0.05 | 0.10 to 0.25 | | | | | 55 000 | 27 500 | | 27 | 12 400 | 10 900 | 9 900 | 8 550 | 6 500 | 3 400 | 1 800 |
| A158 | *Seamless Alloy-Steel Pipe for High-Temperature Service* | | | | | | | | | | | | | | | | | | | | | |
| | Ferritic P3a | OH or EF | 0.15 | 0.30 to 0.60 | 0.04 | 0.05 | 0.45 to 0.75 | | 1.50 to 2.00 | 0.45 to 0.60 | | 60 000 | 30 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic P3b | OH or EF | 0.15 | 0.30 to 0.60 | 0.03 | 0.03 | 0.50 max | | 1.75 to 2.25 | 0.45 to 0.65 | | 60 000 | 30 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic P5a | OH or EF | 0.15 or 0.20 | 0.50 max | 0.03 | 0.03 | 0.50 max | | 4.00 to 6.00 | 0.45 to 0.65 | 0.75 to 1.25 W | 60 000 | 30 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic P5b | OH or EF | 0.15 | 0.50 max | 0.03 | 0.03 | 1.00 to 2.00 | | 4.00 to 6.00 | 0.45 to 0.65 | | 60 000 | 30 000 | | 30 | None Listed | | | | | | |
| | Ferritic P5c[9] | OH or EF | 0.12 | 0.50 max | 0.03 | 0.03 | 0.50 max | | 4.00 to 6.00 | 0.45 to 0.65 | | 60 000 | 30 000 | | 30 | Piping Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic P6 | OH or EF | 0.12 | 0.50 max | 0.03 | 0.03 | 0.50 max | | 12.00 to 14.00 | | 2.00 to 3.00 W | 60 000 | 30 000 | | 30 | None Listed | | | | | | |
| | Ferritic P11 | OH or EF | 0.15 | 0.30 to 0.60 | 0.04 | 0.05 | 0.50 to 1.00 | | 1.00 to 1.50 | 0.45 to 0.65 | | 60 000 | 30 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic P15 | OH or EF | 0.15 | 0.30 to 0.60 | 0.04 | 0.045 | 1.15 to 1.65 | | | 0.45 to 0.65 | | 60 000 | 30 000 | | 30 | None Listed | | | | | | |
| | Austenitic P18a | OH or EF | 0.08 | 2.00 max | 0.03 | 0.03 | 0.75 max | 9.00 to 11.00 | 17.00 to 20.00 | | | 75 000 | 30 000 | | 50 | Boiler Code | 15 000 | 14 600 | 14 000 | 12 300 | 10 000 | |
| | Austenitic P18b[10] | OH or EF | 0.08 | 2.00 max | 0.03 | 0.03 | 0.75 max | 9.00 to 12.00 | 17.00 to 20.00 | | | 75 000 | 30 000 | | 50 | Boiler Code | 15 000 | 14 600 | 14 000 | 12 300 | 10 000 | |
| | Austenitic P18d[11] | OH or EF | 0.08 | 2.00 max | 0.03 | 0.03 | 0.75 max | 9.00 to 12.00 | 17.00 to 20.00 | | | 75 000 | 30 000 | | 50 | None Listed | | | | | | |
| A206 | *Seamless Carbon-Molybdenum Alloy-Steel Pipe for High-Temperature Service Suitable for Bending, Flanging, and Similar Forming Operations and for Fusion Welding* | | | | | | | | | | | | | | | | | | | | | |
| | Ferritic P1 | OH or EF | 0.10 to 0.20 | 0.30 to 0.60 | 0.04 | 0.05 | 0.10 to 0.50 | | | 0.45 to 0.65 | | 55 000 | 30 000 | | 30 | Boiler Code or Piping Code | 11 000 | 11 000 | 10 500 | 8 000 | 5 000 | |
| A213 | *Seamless Alloy-Steel Boiler and Superheater Tubes (These Materials are Sometimes Specified for Pipe for High-Temperature Service and Made to Nominal Pipe Size)* | | | | | | | | | | | | | | | | | | | | | |
| | Ferritic T5 | Elect. Furnace | 0.15 | 0.40 to 0.60 | 0.03 | 0.03 | 0.45 to 0.75 | | 1.50 to 2.00 | 0.60 to 0.80 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic T5 | Elect. Furnace | 0.15 | 0.50 max | 0.03 | 0.03 | 0.50 max | | 4.00 to 6.00 | 0.45 to 0.65 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic T11 | Elect. Furnace | 0.15 | 0.30 to 0.60 | 0.03 | 0.03 | 0.50 to 1.00 | | 1.00 to 1.50 | 0.45 to 0.65 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic T12 | Elect. Furnace | 0.15 | 0.30 to 0.60 | 0.04 | 0.04 | 0.30 max | | 0.80 to 1.10 | 0.45 to 0.65 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic T13 | Elect. Furnace | 0.15 | 0.50 max | 0.03 | 0.03 | 1.00 to 2.00 | | 4.00 to 6.00 | 0.45 to 0.65 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 000 | 6 000 | 4 200 | |
| | Ferritic T14 | Elect. Furnace | 0.15 | 0.30 to 0.60 | 0.03 | 0.03 | 0.50 max | | 1.75 to 2.25 | 0.45 to 0.65 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 000 | 5 850 | |
| | Ferritic T16[12] | Elect. Furnace | 0.12 | 0.50 | 0.03 | 0.03 | 0.50 max | | 4.00 to 6.00 | 0.45 to 0.65 | | 60 000 | 25 000 | | 30 | Boiler Code | 11 000 | 11 000 | 10 800 | 8 000 | 5 850 | |
| | Ferritic T17 | Elect. Furnace | 0.15 to 0.25 | 0.30 to 0.60 | 0.04 | 0.045 | 0.15 to 0.30 | | 0.80 to 1.10 | | 0.15 min V | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | | | | | |
| | Ferritic T21 | Elect. Furnace | 0.15 | 0.30 to 0.60 | 0.03 | 0.03 | 0.50 max | | 2.75 to 3.25 | 0.80 to 1.00 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 250 | 6 250 | |
| | Ferritic T22 | Elect. Furnace | 0.15 | 0.30 to 0.60 | 0.03 | 0.03 | 0.50 max | | 2.00 to 2.50 | 0.90 to 1.10 | | 60 000 | 25 000 | | 30 | Boiler Code | 12 000 | 12 000 | 11 200 | 8 250 | 6 250 | |
| | Austenitic TP304 | Elect. Furnace | 0.08 | 2.00 | 0.03 | 0.03 | 0.75 max | 8.00 to 11.00 | 18.00 to 20.00 | | | 75 000 | 30 000 | | 35 | Boiler Code | 15 000 | 14 600 | 14 000 | 12 300 | 10 000 | |
| | Austenitic TP316 | Elect. Furnace | 0.08 | 2.00 | 0.03 | 0.03 | 0.75 max | 11.00 to 14.00 | 16.00 to 18.00 | 2.00 to 3.00 | | 75 000 | 30 000 | | 35 | Boiler Code | 15 000 | 14 600 | 14 000 | 12 600 | 11 200 | |
| | Austenitic TP321[13] | Elect. Furnace | 0.08 | 2.00 | 0.03 | 0.03 | 0.75 max | 9.00 to 13.00 | 17.00 to 20.00 | | | 75 000 | 30 000 | | 35 | Boiler Code | 15 000 | 14 600 | 14 000 | 12 300 | 10 000 | |
| | Austenitic TP347[14] | Elect. Furnace | 0.08 | 2.00 | 0.03 | 0.03 | 0.75 max | 9.00 to 13.00 | 17.00 to 20.00 | | | 75 000 | 30 000 | | 35 | Boiler Code | 15 000 | 14 600 | 14 000 | 12 300 | 10 000 | |
| A280 | *Seamless Chrome-Molybdenum Alloy-Steel Pipe for High-Temperature Service Suitable for Bending, Flanging, and Similar Forming Operations and for Fusion Welding* | | | | | | | | | | | | | | | | | | | | | |
| | Seamless | OH or EF | 0.10 to 0.20 | 0.30 to 0.60 | 0.04 | 0.05 | 0.10 to 0.50 | | 0.40 to 0.60 | 0.45 to 0.65 | | 55 000 | 30 000 | | 30 | Boiler Code | 11 000 | 11 000 | 10 500 | 8 000 | 5 000 | |

**See footnotes for table on next page.**

# STEEL PIPE SPECIFICATIONS

THERE are several American Society for Testing Materials specifications for pipe listed in the American Standard Code for Pressure Piping and the American Society of Mechanical Engineers Boiler Construction Code as available for power piping applications. After eliminating nonferrous and cast iron pipe, the 10 separate specifications abstracted in the table on the preceding page remain. These 10 specifications embrace some 54 different grades of material.

Some idea of the purposes for which the several specifications are suited can be gathered from their *titles* with condensed *scope clauses* as presented in the table. The order of listing specifications follows the sequence of the ASTM numbering system and merely reflects the succession in which the specifications were issued.

In general, the *quality* of the product is reflected in the extent to which *chemical composition* and *physical properties* are specified. From a glance at the table, it is immediately evident which specifications have sufficient requirements to define adequately what the product is like and to assure obtaining reasonable uniformity of quality.

Further indications of *quality* are the *process* by which the steel is made and the *melting practice*. By "process" is meant the bessemer, open hearth, electric furnace, or duplexing process of manufacture used in producing the steel. "Melting practice" refers to whether the steel is an "open" or "rimmed" steel, or whether it is "killed" or deoxidized during the process of manufacture. "Killed" steels are superior in many respects, among other things being of more uniform structure and better adapted to cold bending and to severe hot forming operations.

Both *aluminum* and *silicon* are commonly used together as *deoxidizers*, and each has a specific effect on the final product. The aluminum tends to give a fine grained steel which behaves well in rolling but has poor resistance to graphitization in service owing to the aluminum. The silicon, on the other hand, tends to give a coarse grained steel having superior strength at elevated temperatures and less susceptibility to graphitization. Hence, it is sometimes specified that a steel shall be "killed with a preponderance of silicon" and a requirement is set as to the minimum amount of silicon which must be found present on analysis. This requirement, however, does not prevent the use of an excessive amount of aluminum from the standpoint of graphitization, and more specific restrictions should be considered in ordering new pipe if carbon steel is to be used for temperatures above 800 F, or carbon-moly above 900 F. Several of the specifications shown in the table have minimum silicon requirements and it will be noted that these grades are allowed higher *S* values than similar materials having less silicon.

Another preliminary slant on the purposes for which the several specifications are suited can be obtained from the allowable stresses or "*S* values" at different temperatures listed in the table for the various grades of material. The *S* values are the maximum allowable stresses at different operating temperatures set by the code committees for use in the formulas for computing the thickness of pipe wall required with respect to bursting stress due to internal pressure. In the Code for Pressure Piping the *S* values also serve as a guide in setting maximum longitudinal stress caused by a combination of internal pressure, and bending due to expansion and dead weight between supports. Tabulating these *S* values on the same sheet with the chemical compositions, physical properties, and other characteristic information pertaining to each grade of material helps to make it salient features distinguishable from the corresponding features of other grades.

Owing to space limitations, no values have been shown for temperatures above 1000 F, although such values have been set in the Boiler Code for some alloys. Likewise several sets of *S* values for intermediate temperatures have been omitted for the sake of condensing the table.

The *joint or seam efficiency* possessed by each kind of pipe was considered by the code committee in setting *S* values. These joint efficiencies are incorporated in the *S* values shown in the table.

[For a complete discussion of this subject, see article by Sabin Crocker in Heating, Piping & Air Conditioning, January 1946.]

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**Footnotes for table on preceding page.**

[1]Abbreviations: *AB*, acid bessemer; *EF*, electric furnace; *EFW*, electric fusion welded; *ERW*, electric resistance welded; *OH*, open hearth.

[2]In addition to the tests specified, each length of pipe shall be given a hydrostatic test and other physical tests as prescribed in the respective specification.

[3]For intermediate *S* values, see American Standard Code for Pressure Piping, ASA B31, or ASME Boiler Construction Code. The Boiler Code *S* values below 650 F are the same as at 650 F in all cases, whereas the Piping Code values are as tabulated. Allowable stresses for A53 and A135 pipe above 750 F are for the Boiler Code only; likewise those for non-silicon-killed A155 pipe at 1000 F. The Boiler Code also contains silicon-killed varieties of the following items for which there is no equivalent in the Piping Code: (a) A53 seamless pipe in both grades A and B to which it assigns the same *S* values as shown for silicon-killed A106 pipe in this table; and (b) A135 resistance welded pipe.

[4]Welded pipe 4 in. and under in nominal diameter may be butt welded. Welded pipe over 4 in. in nominal diameter shall be lap welded or electric welded.

[5]Grade A pipe should be used for close coiling, cold bending, or forge welding.

[6]Not shown in the ASTM specification, but can be obtained with this silicon range.

[7]For applications where the temperature is below 650 F, *S* values equal to the corresponding seamless grades may be used if the pipe is subjected to supplemental tests and/or heat treatments which demonstrate the strength of the weld to be equal to the minimum tensile strength specified for the pipe.

[8]Either molybdenum or tungsten shall be used.

[9]Grade P5c shall have a titanium content of not less than four times the carbon content and not more than 0.70 per cent; or a columbium content of eight times the carbon content.

[10]Grade P8b shall have a titanium content of not less than five times the carbon content and not more than 0.60 per cent.

[11]Grade P8d shall have a columbium content of not less than 10 times the carbon content and not more than 1.0 per cent.

[12]Grade T16 shall have a titanium content of not less than four times the carbon content and not more than 0.70 per cent.

[13]Grade TP-321 shall have a titanium content of not less than five times the carbon content and not more than 0.60 per cent.

[14]Grade TP-347 shall have a columbium content of not less than 10 times the carbon content and not more than 1.00 per cent.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

# Heat Losses Through Wetted Walls

By E. C. Willey*, Corvallis, Ore.

This paper is the result of research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in cooperation with the Engineering Experiment Station, Oregon State College.

**SUMMARY—Studies were made at Oregon State College to ascertain the effect of exposure to rains and wind on the overall heat loss from exterior building walls. Test equipment was set up to simulate natural conditions. Under still air conditions the overall heat transfer coefficient *U* of the test wall was 0.241 Btu per (sq ft) (hr) (F deg). With a 15 mph wind this was increased to 0.283. With a 15 mph wind and the equivalent of ¼ in. of rain per hour sweeping the outside surface, the heat transmission coefficient increased by 12.4 per cent to 0.318. Variations in temperature of the rain made little variations in the heat loss.**

FOR many years heating engineers of the northwest country have conceded that walls exposed to the wind and rain have a much higher heat loss than normally would be calculated from their wall coefficients and the degree day records.

The late F. C. Houghten, director of the ASHVE Research Laboratory, suggested that studies be made to determine the effect of wetted surface on the overall heat loss of a wall by placing heat flow meters on walls which were exposed to the prevalent rains and winds. An attempt was made to do this, but it so happened that the following two winters were so mild and dry that it was impossible to get a sufficient number of significant readings. It was decided, therefore, that the quickest and most reliable way to obtain this information would be to build equipment to reproduce the conditions mechanically.

Late in 1940 a committee of members of the Oregon chapter of ASHVE met to study the possibilities of building suitable equipment and carrying on this research project. This committee consisted of J. Donald Kroeker, chairman, T. H. McClung, James F. McIndoe, J. E. Yates and Earl C. Willey. Subsequent members were Thomas E. Taylor, W. J. Kollas, W. Bruce Morrison, Albert Freeman and Donald E. Cooper.

This committee first enlisted the assistance of manufacturers and jobbers in and around Portland, Oregon, and obtained promises of support of the project in the form of materials and supplies. With these promises and the cooperation of the Oregon State College Engineering Experiment Station, the building of the equipment was started. The work progressed slowly because of war conditions, especially the scarcity of materials and lack of help.

In the fall of 1942 the Committee on Research made funds available for the continuation of the project and, though the work progressed somewhat faster, many unforeseen difficulties arose, some requiring rebuilding important parts of the equipment.

## Equipment

The general arrangement of test equipment (see Fig. 1) was similar to the hot box cold room used by the University of Minnesota.[1] This consisted of a cold room with floor area 10 ft x 10 ft and ceiling 8 ft. In the center of one wall there was an opening 5 ft x 5 ft over which (on the outside) a hot box was built with dimensions of 5 ft x 5 ft x 5 ft. This box was termed the outer hot box. Suspended in the center of the outer hot box was an inner hot box 3 ft x 3 ft x 3 ft. The inner edges of the outer and inner hot boxes were flush and padded with heavy felt against which the test wall specimen was secured.

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Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Montreal, Que., Canada, June, 1946.

[1] Thermal Conductivity of Building Materials, *Bulletin No. 13*, Engineering Experiment Station, University of Minnesota.

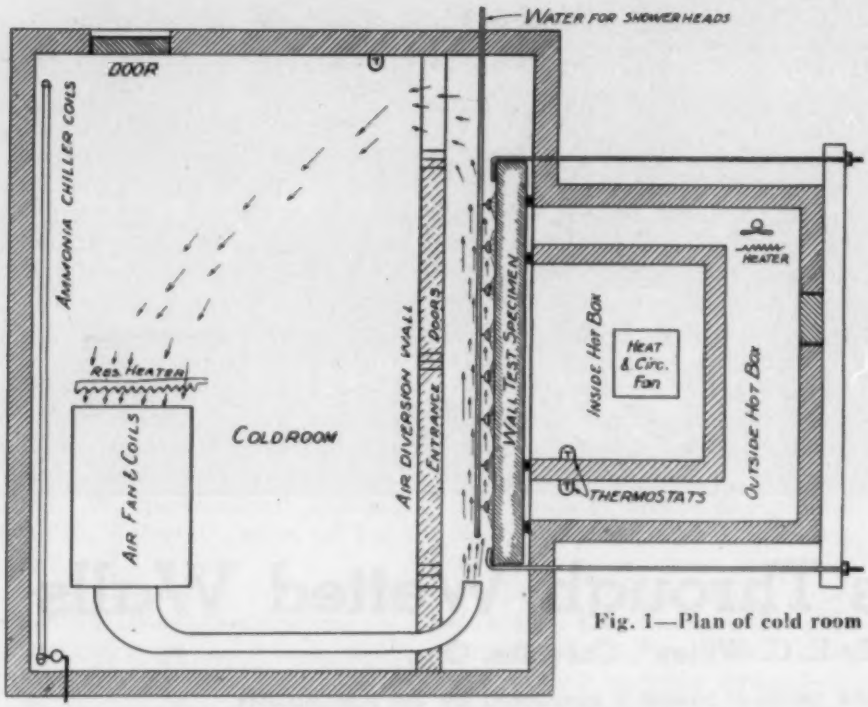


Fig. 1—Plan of cold room

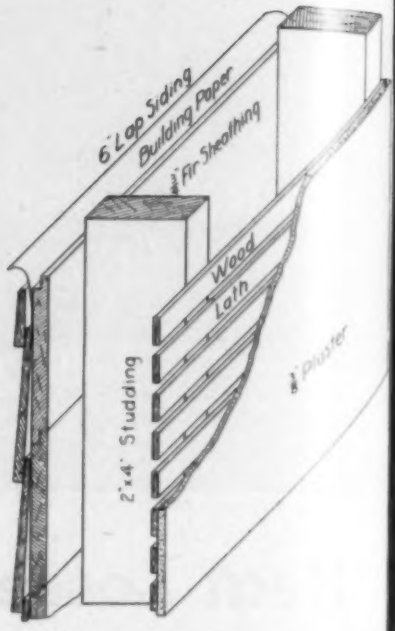


Fig. 3—Construction of test wall

A fan located in the cold room delivered air through a duct to the surface of the test wall. The exhaust opening of the duct was 6 in. x 6 ft and was arranged so that the air was distributed evenly over the surface of the wall specimen.

Near the top of the wall specimen a series of small water sprays was arranged to wet the wall and simulate rain conditions. Water supply for this was taken either directly from the city water supply or precooled to any desired temperature. Refrigeration for the cold room was supplied through an ammonia compressor and direct expansion coils in the room.

Temperatures were measured by copper constantan thermocouples and a potentiometer. The thermocouples were placed four on the outside and four on the inside of the test wall specimen. These were located 6 in. out from the wall and equidistant from the center so that each thermocouple would register the temperature of about one-fourth of the wall section. Thermocouples were also placed on the surface at center of the test wall. In addition, there were couples placed in the center (outside and inside) of each of the walls of the inner hot box to register the temperature of the inside and outside hot boxes and assure that no heat left the inner hot box except through the test portion of the wall. All thermocouples were shielded, as shown in Fig. 2, to avoid radiation effect and all were connected by leads to a multipoint switch and through a common cold junction to a potentiometer.

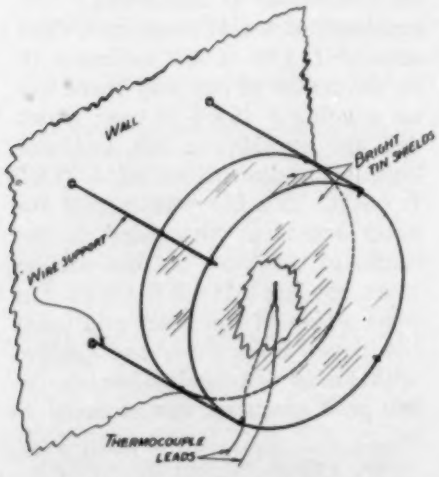


Fig. 2—Thermocouple shield

The test wall (Fig. 3) was of frame construction consisting of wood lath and ½ in. plaster on the inside; 2 x 4 studding, ¾ in. shiplap, tar paper and 6 in. cedar siding on the outside. The siding was given three coats of outside white paint.

Heat was supplied to the inside hot box by means of electric resistance heaters. These were enclosed in a box so that no part of the heater was directly exposed to the test wall or the sides of the inside hot box. A small electric fan provides air circulation in the heater box bringing in the air at the bottom and distributing it in all directions from the top. (See Fig. 4).

The outside hot box also was warmed by means of an electric heater which in turn was shielded from direct radiation to the inside hot box and air in this case too was distributed by means of an electric fan.

Temperatures of the inside and outside hot boxes were controlled by thermostats through magnetic switches to the power sources. Electric power measurement was made

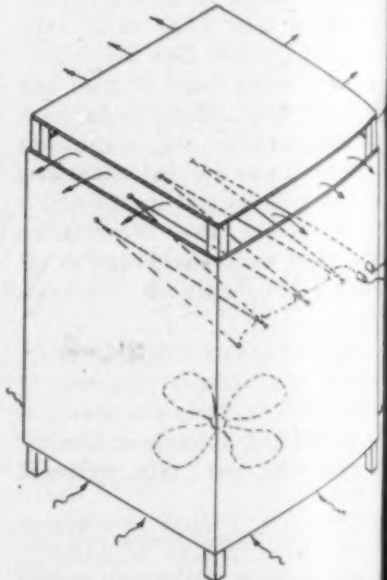

Fig. 4—Inside hot box and electric resistance heaters

ig. 5—Wall construction of inside hot box

ith a watt hour meter which was ead to one tenth watt hour. The att hour meter was checked by standard test meter on each read-ng.

The walls of the cold room were onstructed of 2 in. x 4 in. studding ith fir plywood on each side. Space etween the studding was filled ith cedar shavings. The ceiling ad plywood on the inside and the oists were filled with 6 in. of cedar havings. The outside hot box was imilar to the cold box in construc-ion. The inside hot box was con-tructed of three layers of 1 in. nsulating board encased on each de with fir plywood (see Fig. 5).

As shown in Fig. 1, the plan iew of the test apparatus, the test all is held against the hot boxes y means of long screw clamps and sealed by heavy felt padding. The iversion wall aids in directing the ir streams across the face of the st wall and also prevents the oisture from the shower heads etting into the cold room. This di-rsion wall is removable in order permit changing the test walls.

A large metal trough was in-alled under the test wall to collect e water, which could be recircu-ted or diverted to the sewer. A ater recirculation pump was pro-ded to circulate the water rough a cooling coil in the fan stem to maintain any desired mperature.

Thermostatic controls actuated e expansion valve in the ammonia frigeration line to control the ld room temperatures. Also an-her control consisted of an electric sistance heater placed at the in-ke of the circulation fan which ould act if the temperatures opped below any set minimum mperature.

## Test Procedure

In general the tests were made to determine the additional heating load which would result from the wetting of the outer surface of a wall. As this was a relative condition, it was not considered necessary to make tests on many walls but only to determine the relative results on one type of wall. The wall used was of a type which is very common in the Pacific northwest country. The first group of tests was made to determine the overall heat transfer coefficient $U$ for the wall under conditions of still air. Temperatures of 72 F to 74 F were used throughout all the series for the inside temperature. The cold room temperatures varied from 30 F to 45 F.

The second group of tests was similar to the first but was made with air movements of from ten to twenty miles per hour. In both the first and second group, the coefficients obtained checked very closely to those given in the ASHVE GUIDE for this specific construction of wall.

The third group of tests was made using the water spray. This group was divided into two parts. The first was made by varying the water temperatures from 36 F to 50 F and keeping the amount of water flow constant. The second was made using constant water temperature but varying the flow from an equivalent of ¼ in. rainfall to ¾ in. rainfall per hour. In each of these tests, calculations were made to determine the general overall coefficient $U$ with the specific conditions.

All tests were preceded by a long warming up period to insure a condition of equilibrium. Then readings were taken every fifteen minutes of the following: (1) temperatures of cold room, four points on the cold room side of wall and on the center surface of wall, four points on the inside of test wall, five wall temperatures on inside of inside hot box and the five temperatures on the outside wall of inside hot box; (2) temperature of spray water (when spray was used); (3) reading of the watt meters.

## Results

The general results of this investigation may be summed up in a few words. However, of equal importance are some of the findings in the early part of the investigation which resulted in changes in the equipment and procedure.

When the equipment was first ready for tests, there were no provisions for guarding the thermocouples. The result was that temperatures varied much more than seemed reasonable. Also the heaters were exposed to view of the walls and the temperatures were found to be much higher on the walls nearest the heater. This was rectified by shielding the couples. It was still noticed that when the fan was running, the temperatures would level off; but when the fan stopped, they would immediately begin changing. It was, therefore, decided to allow the fans to run constantly during the tests.

The question as to the significance of temperature of the rain arose soon after the first few tests were made using the wet surface.

Investigation at the offices of the weather bureau showed that no records had been kept of the actual temperature of the rain, but it was very evident that it was not always the same temperature as the surrounding air since even in warm weather hail may fall at 32 F.

Rather than spending a winter of investigation to determine the average temperature of the rainfall, a series of tests was made in the test apparatus using different temperatures of water on the wall. The results of these were very gratifying as the heat loss, in all cases using water from 36 F to 50 F which was both colder and warmer

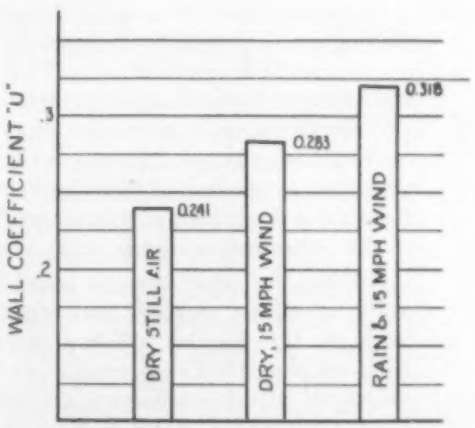


Fig. 6—Comparison of average overall heat transfer coefficients for the three conditions of test

than the surrounding air, remained practically constant. This indicated that the evaporation of the moisture rather than the temperature was causing the cooling effect.

The final average overall coefficient $U$ from all tests with the wall under dry still air conditions was 0.241 Btu per (hr) (sq ft) (Fahrenheit degree). The final average of all tests with the dry wall exposed to an average 15 mph wind was 0.283. The final average of tests conducted under wind and rain conditions was $U = 0.318$ (see Fig. 6).

**Summary of Test Results**

| Date of run | Condition | $t_2$-$t_1$[a] F deg | Duration hours | Total watt hr | C Btu/(hr)(sq ft) F deg |
|---|---|---|---|---|---|
| 8- 2-45 | Dry, still air | 33.0 | 6 | 126 | .241 |
| 8-27-45 | | 32.9 | 6 | 126 | .241 |
| 9- 4-45 | | 31.6 | 6 | 121 | .242 |
| 12- 5-45 | | 41.3 | 6 | 157 | .240 |
| | | | | | .241 avg |
| 8-31-45 | Dry, 15 mi. wind | 33.2 | 12 | 312 | .296 |
| 12- 6-45 | | 41.2 | 5 | 151 | .278 |
| 12- 9-45 | | 44.6 | 2 | 65 | .276 |
| 12-11-45 | | 46.1 | 28 | 963 | .282 |
| | | | | | .283 avg |
| 8-25-45 | 15 mi. wind | 33.2 | 11 | 307 | .316 |
| 9- 1-45 | ¼ in. rainfall | 32.4 | 16 | 439 | .322 |
| 9- 5-45 | sweeping outside | 32.1 | 7 | 190 | .321 |
| 11-24-45 | | 35.0 | 1 | 29 | .314 |
| 12- 8-45 | | 40.3 | 5.5 | 186 | .318 |
| | | | | | .318 avg |

[a]The average temperature of all runs on the hot side was 72 F.

### Conclusions

From the results of these experiments, it is very evident that rain conditions will increase the heat loss through a wall. This may not be of sufficient proportion to warrant adding radiation, but should be given consideration in calculating the yearly fuel bills.

The bar chart, Fig. 6, shows that the wetted wall surface will add as much heat load to a wall as the normal 15 mph wind adds to the still air condition. The difference between $U = 0.283$ for the dry wind condition to $U = 0.318$ in the wet condition is 12.4 per cent.

When calculating the heat loss of a building for the purpose of estimating fuel consumption, consideration should be given to those walls which are exposed to the prevailing rains and wind. To these an additional load of 12.4 per cent should be added for that part of the season when the rain and winds prevail. This would not be at a time when the heat loss was maximum, of course, for at that time the weather would be freezing.

It has long been a common remark among building owners after a mild but rainy season, *even though we have had a mild winter, I have used more fuel than last winter when it was really cold.* This, no doubt, is due to a great extent to the 12.4 per cent additional load caused by the wet surface.

## MEETING AND EXPOSITION IN JANUARY, 1947

Already 200 leading manufacturers have engaged 75 per cent of the total exhibit space available for the 7th International Heating & Ventilating Exposition, scheduled for Lakeside Hall, Cleveland, Ohio, January 27 to 31, 1947. It will be held under the auspices of the AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS and in conjunction with the 53rd Annual Meeting which will be held in Hotel Statler, Cleveland.

Manufacturers of heating, ventilating and air conditioning equipment expect to eliminate production and material shortage difficulties and are planning to introduce their newest models at the Exposition. It promises to be one of the largest Heating & Ventilating Expositions in the series originated in 1930.

Among the other groups scheduling meetings during the same week is the *National Warm Air Heating and Air Conditioning Association*, with headquarters at the Hotel Cleveland. Charles F. Roth is manager and E. K. Stevens is associate manager of the Exposition.

## An Invitation to Members

The Meetings Committee wishes to encourage the authors who can and will prepare good technical papers for presentation to our Society. We are particularly interested in papers dealing with new or novel developments and which material can be incorporated into the literature and will assist others in the solution of current problems.

Any one of the committee members will be glad to consult by mail or otherwise with authors to predetermine whether the particular paper is desired and can be used. We need good papers on air conditioning of all kinds and new papers on air distribution, industrial hygiene and industrial ventilation.

Papers must be presented first to the Publication Committee for approval for publication and then are passed on to the Meetings Committee for selection to use at the Annual or Semi-Annual Meetings. We need papers planned now to take care of the Annual Meeting in January 1947. If you have any papers you would like to suggest, please communicate with us.

THE MEETINGS COMMITTEE

Lester T. Avery, *Chairman*
F. W. Hutchinson
E. N. McDonnell

# Periodic Heat Flow—Composite Walls or Roofs

By C. O. Mackey* and L. T. Wright, Jr.**, Ithaca, New York

**SUMMARY—A method is presented for finding the homogeneous equivalent of a composite wall or roof. The equivalent homogeneous wall or roof will give the same contribution to the cooling load at the same time as does the composite construction. Only two thermal properties are necessary to define the equivalent construction, and equations are presented for each property.**

THIS paper is the result of research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in cooperation with Cornell University. The study is an extension of the work previously done on heat flow through homogeneous materials and reported in another paper[1]. The contents of this paper in slightly different form has been presented as a report to the ASHVE Research Technical Advisory Committee on Cooling Load in Summer Air Conditioning.

## Composite Constructions

The type of composite construction with which the present discussion is primarily concerned might be described as a *sandwich* type. The wall or roof is composed of two or more layers arranged so that heat flows through the layers in series. Each layer itself is assumed to be a homogeneous material making perfect thermal contact with each adjacent layer.

The basic problem is to determine the temperature of the inside surface of the wall or roof at any time for the case where (1) the incident solar radiation and temperature of the outdoor air are periodic, (2) the temperature of the indoor air is constant, (3) the outdoor air film coefficient of heat transfer is 4.0 and (4) the indoor air film coefficient of heat transfer is 1.65 Btu/hr ft² F.

## Equivalent Homogeneous Construction

The basic problem has been solved mathematically for two and three layer constructions and the important equations are given in a more complete paper of which this is an abbreviated form. In order to make the results of this mathematical solution more practical, the solution has been used to define an *equivalent homogeneous construction. The equivalent homogeneous construction is here defined as a simple homogeneous wall or roof which will have the same variation in indoor surface temperature with time as does the actual composite wall or roof under identical ambient conditions.* The rate of heat transfer from the inside surface to the room air is dependent on the temperature of the inside surface and the inside film coefficient of heat transfer. Thus, the composite construction and its equivalent homogeneous construction will give the same contribution to the cooling load at the same time. It is true that the temperature gradients will be different in the composite and homogeneous constructions, but this is unimportant in finding the cooling load. Also the equivalent construction defined in this paper is the equivalent *only in the particular case of periodic heat flow treated in this study and is not the equivalent construction for all other possible cases of unsteady or transient heat flow.*

Two thermal properties are necessary to define the equivalent homogeneous construction, the thermal resistance $\left(\frac{L}{k}\right)_s$ and the quantity $(k\rho c)_s$,

*where*

$L$ = thickness of the material, feet;
$k$ = thermal conductivity, Btu/hr ft F;
$\rho c$ = volumetric specific heat, Btu/ft³ F.

Subscript $s$ denotes equivalent homogeneous construction.

The thermal resistance of the homogeneous material is determined by the fact that the steady flow characteristics of both the composite and homogeneous constructions must be the same. Let the material of the exterior surface of the wall or roof be designated by the subscript $L$, and the material of the inside (room side) surface of the wall or roof be designated by $o$. The materials of interior, central layers of the composite wall or roof will be designated by $m_1$, $m_2$, etc.

For a multilayer, composite construction, the thermal resistance of the equivalent homogeneous construction is

$$\left(\frac{L}{k}\right)_s = \left(\frac{L}{k}\right)_o + \left(\frac{L}{k}\right)_L + \left(\frac{L}{k}\right)_{m1} + \left(\frac{L}{k}\right)_{m2} + \ldots . \quad (1)$$

If the construction contains an air space, it is recommended that the thermal resistance of the air space be used for $\left(\frac{L}{k}\right)_m$ in Equation 1. Since the mean temperature of this air space will commonly be above 80 F for summer conditions, a reasonable value of thermal resistance for air spaces of 1 in. or more is 0.75 hr ft²F/Btu.

The property $(k\rho c)_s$ of the equivalent homogeneous wall or roof is determined from an empirical equation derived to fit the results obtained from a number of cases solved by the rational, complete equations which have been derived for this case of unsteady heat flow.

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[1] "Periodic Heat Flow—Homogeneous Walls or Roofs, by C. O. Mackey and L. T. Wright, Jr. (ASHVE JOURNAL SECTION, *Heating, Piping, and Air Conditioning, September*, 1944.)

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Montreal, Que., Canada, June, 1946.

For a multilayer composite construction, the property $k\rho c$ of the equivalent, homogenous construction is

$$(k\rho c)_e = \frac{1.1\left(\frac{L}{k}\right)_e (k\rho c)_o + 1.1\left(\frac{L}{k}\right)_{m1} (k\rho c)_{m1} + 1.1\left(\frac{L}{k}\right)_{m2} (k\rho c)_{m2} + \ldots}{\left(\frac{L}{k}\right)_e}$$

$$+ \frac{(k\rho c)_L \left[\left(\frac{L}{k}\right)_L - 0.1\left(\frac{L}{k}\right)_o - 0.1\left(\frac{L}{k}\right)_{m1} - 0.1\left(\frac{L}{k}\right)_{m2} - \ldots\right]}{\left(\frac{L}{k}\right)_e} \quad \ldots\ldots (2)$$

In certain cases, the multiplier (in brackets) of the term $(k\rho c)_L$ in Equation 2 becomes negative; when this occurs, the entire product should be called zero. This negative value is encountered when the thermal resistance of the outside layer is small in comparison with the thermal resistances of the other layers.

Where one of the layers is air (air space), the $(k\rho c)_m$ of the air space may be treated as zero.

### Examples

Some examples will be given to illustrate the determination of the properties as a simple, homogeneous wall or roof which is the equivalent of the actual, composite wall or roof (See Table 1).

The simple, homogeneous equivalent of Wall A has a thermal resistance (from Equation 1) of

$$\left(\frac{L}{k}\right)_e = 10 + 0.667 = 10.667 \text{ hr ft}^2\text{F/Btu},$$

and an equivalent $k\rho c$ property (from Equation 2) of

$$(k\rho c)_e = \frac{1.1\ (10)\ (0.1)}{10.667} = 0.103 \text{ Btu}^2\text{/hr ft}^4\text{F}^2$$

Note that the last term in the numerator of Equation 2 has been ignored because it is negative.

For Wall B, the simple, homogeneous equivalent wall has a thermal resistance (from Equation 1) of

$$\left(\frac{L}{k}\right)_e = 0.23 + 0.44 + 0.80 + 0.75 = 2.22,$$

and an equivalent $k\rho c$ property (from Equation 2) of

$$(k\rho c)_e = \frac{1.1\ (0.23)\ (5.4) + 1.1\ (0.8)\ (8.3) + 20\ (0.44 - 0.023 - 0.08 - 0.075)}{2.22} = 6.27$$

For roof C, the simple, homogeneous equivalent roof has a thermal resistance (from Equation 1) of

$$\left(\frac{L}{k}\right)_e = 0.333 + 0.28 + 0.30 = 0.913,$$

and an equivalent $k\rho c$ property (from Equation 2) of

$$(k\rho c)_e = \frac{1.1\ (0.333)\ (35) + 1.1\ (0.3)\ (0.15) + 1.2\ (0.28 - 0.0333 - 0.03)}{0.913} = 14.4$$

The simple, homogeneous equivalent of Roof D has a thermal resistance (from Equation 1) of

$$\left(\frac{L}{k}\right)_e = 0.23 + 0.28 + 0.30 + 0.333 + 0.75 = 1.923.$$

and an equivalent $k\rho c$ property (from Equation 2) of

$$(k\rho c)_e = \frac{1.1\ (0.23)\ (5.4) + 1.1\ (0.3)\ (0.15) + 1.1\ (0.333)\ (35)}{1.923}$$

$$+ \frac{1.2\ (0.28 - 0.023 - 0.03 - 0.0333 - 0.075)}{1.923} = 7.47$$

### Thermal Properties and Apparent Densities of Building Materials

The apparent density of a building material is extremely important in determining the properties that affect its thermal behavior. For densities above about 5 lb per cu ft, the thermal conductivity of a material generally increases as the density increases, regardless of the origin of the material. The volumetric specific heat is the product of the gravimetric specific heat and the apparent density. There is not a wide range in gravimetric specific heats of non-metallic solids; solids of mineral origin have gravimetric specific heats between about 0.15 and 0.25 Btu/lb F, while the specific heats of *dry* solids of vegetable origin are commonly between 0.3 and 0.4 Btu/lb F at temperatures important in this study. Consequently, the volumetric specific heat of building materials increases as the apparent density increases. The product of thermal conductivity and volumetric specific heat is a thermal property that has been shown to be important in its effect upon cooling load with unsteady flow of heat; this property increases very rapidly with an increase in apparent density. Empirical equations are offered that relate thermal conductivity and the product of thermal conductivity and volumetric specific heat to apparent density. These equations are approximate and should be used only when there are no reliable test data that give the desired properties.

Thermal Properties of Dry, Non-Metallic Solids (approximate):

*Apparent densities, $\rho$, between 5 and 20 lb/ft³*

Vegetable or mineral origin:
$k = 0.0137\rho^{0.3}$ Btu/hr ft F

Vegetable origin:
$k\rho c = 0.0045\rho^{1.3}$ Btu²/hr ft⁴ F²

Mineral origin:
$k\rho c = 0.0027\rho^{1.3}$ Btu²/hr ft⁴ F²

*Apparent densities, $\rho$, between 20 and 60 lb/ft³*

Vegetable or mineral origin:
$k = 0.00118\rho^{1.12}$ Btu/hr ft F

Vegetable origin:
$k\rho c = 0.00039\rho^{2.12}$ Btu²/hr ft⁴ F²

Mineral origin:
$k\rho c = 0.00024\rho^{2.12}$ Btu²/hr ft⁴ F²

*Apparent densities, $\rho$, of 60 lb/ft³ and higher*

Any origin:
$$k = \left(\frac{\rho}{143}\right)^{2.5} \text{ Btu/hr ft F}$$

Any origin:
$$k\rho c = \left(\frac{\rho}{55}\right)^{3.5} \text{ Btu}^2\text{/hr ft}^4\text{ F}^2$$

The thermal properties of water are considerably out of line with those of non-metallic solids. The

Table 1—**Determination of Properties of a Simple Homogeneous Wall or Roof, Equivalent to the Actual Composite Wall or Roof**

| Construction | Layer | Sym | Material | Thermal Conductivity $k$ Btu/hr ft F | Thickness in. | Thickness L ft | Thermal Resistance, $\frac{L}{k}$ hr ft²F/Btu | $k\rho c$ Btu²/hr ft⁴ F² |
|---|---|---|---|---|---|---|---|---|
| Wall A | Outside | $L$ | Concrete | 1.0 | 8 | 0.667 | 0.667 | 35 |
| | Inside | $o$ | Corkboard | 0.025 | 3 | 0.25 | 10.0 | 0.10 |
| Wall B | Outside | $L$ | Face Brick | 0.767 | 4 | 0.333 | 0.44 | 20 |
| | Central | $m_1$ | Common Brick | 0.417 | 4 | 0.333 | 0.80 | 8.3 |
| | Central | $m_2$ | Air Space | | | | 0.75 | 0 |
| | Inside | $o$ | Plaster on Metal Lath | | | | 0.23 | 5.4 |
| Roof C | Outside | $L$ | Built up Roofing | 0.11 | 0.375 | 0.0312 | 0.28 | 1.2 |
| | Central | $m_1$ | Insulating Board | 0.028 | 1 | 0.0833 | 0.30 | 0.15 |
| | Inside | $o$ | Concrete | 1.0 | 4 | 0.333 | 0.333 | 35 |
| Roof D | Outside | $L$ | Built up Roofing | 0.11 | 0.375 | 0.0312 | 0.28 | 1.2 |
| | Central | $m_1$ | Insulating Board | 0.028 | 1 | 0.0833 | 0.30 | 0.15 |
| | Central | $m_2$ | Concrete | 1.0 | 4 | 0.333 | 0.333 | 35 |
| | Central | $m_3$ | Air Space | | | | 0.75 | 0 |
| | Inside | $o$ | Plaster on Metal Lath | | | | 0.23 | 5.4 |

thermal conductivity of water is about 0.35 Btu/hr ft F at temperatures important in this study, while dry non-metallic solids with the same density as water will have thermal conductivities only one third of that of water. Similarly, $k\rho c$ for water is about 21.8 Btu²/hr ft⁴ F², while $k\rho c$ of any dry non-metallic solid of the same density as water is only about 7 per cent of that of water. It follows that the presence of moisture in materials of construction will considerably modify their thermal behaviors.

## Some Conclusions Concerning Thermal Behavior of Composite Walls or Roofs

All conclusions summarized here apply only to the type of unsteady flow of heat defined in this study—periodic outdoor air temperature and incident solar radiation with constant temperature of the indoor air.

For any composite wall or roof of *sandwich* construction, there is an exact *thermal* equivalent in some simple, homogeneous material. Whether or not any available building material has the exact properties required of this equivalent material is another question. The significance of the first conclusion will be illustrated by examples. Consider a two layer wall with 12 in. of concrete on the outside and 1 in. of cork on the inside. The value of $(k\rho c)_e$ for an equivalent homogeneous wall may be shown to be 5.5, while $\left(\frac{L}{k}\right)_e = 4.3$. Plaster, or a non-metallic solid with an apparent density of 90 lb per cu ft would have about this value of $k\rho c$; in a thickness of about 16 in., plaster or a non-metallic solid with an apparent density of 90 lb per cu ft would have the same thermal resistance as the concrete and cork wall. Therefore, a simple, homogeneous wall of 16 in. of plaster is the *thermal* equivalent of the composite wall made up of 12 in. of concrete lined with 1 in. of cork; each wall would contribute approximately the same amount to the cooling load at the same time of day when exposed on the outside to a periodic air temperature and solar radiation while the temperature of the indoor air is held constant, provided the solar absorptivity of the exterior surface of each wall is the same.

As a second example, consider a composite wall made up as follows: 4 in. face brick, 25/32 in. wood sheathing, air space, ½ in. insulating board and ½ in. plaster. The value of $(k\rho c)_e$ of the equivalent homogeneous wall may be found as 0.9, while the thermal resistance of the equivalent homogeneous wall must be 3.82. Pine would have substantially this value of $k\rho c$ and if used in a thickness of 3 in. would have about the same *thermal* resistance as the composite, brick veneer wall. Therefore, a simple, homogeneous wall of 3 in. of pine is the *thermal* equivalent of the composite brick veneer wall of this example and each wall would make approximately the same contribution to the cooling load at the same time of day provided the solar absorptivity of the exterior surface of each wall is the same.

A second conclusion is that the order of the materials in a composite wall or roof affects the thermal behavior of the construction. In the steady flow of heat, the order in which the successive layers of the materials are encountered in series has no effect upon the overall rate of heat conduction; this is not the case for periodic, unsteady flow of heat. A striking example of this conclusion is the case of a two layer composite construction consisting of 6 in. of concrete and 1 in. of rigid insulation. With the concrete on the outside, the time lag is about 5 hours; when the insulation is on the outside, the time lag is about 11 hours. In general, the facts concerning the thermal behavior of a composite wall of two materials in series are: if the two materials have the same solar absorptivities, interchanging the two materials will *not* affect the *daily* gain of heat, but use of the material of smaller density as the outdoor layer will *decrease* the *maximum* rate of heat transfer to the indoor air and *increase* the lag in time between the time of maximum rate of heat entry into the outdoor layer and the time of maximum rate of heat transfer to the inside of the enclosure.

For a composite construction of three or more layers in series, this study indicates that interchanging any of the middle layers with the inside layer will have no great effect upon the thermal behavior of the wall or roof. Interchanging any of the middle layers or the inside layer with the *outside* layer, however, may affect the *maximum* rate of heat transfer to the indoor air and the time of that maximum. The direction of these changes is similar to the case of the two layer construction. If a material of low density (low thermal conductivity and low volumetric specific heat) in the middle or on the inside surface is exchanged with an outdoor layer of high density (high thermal conductivity and high volumetric specific heat), the result is a de-

crease in the maximum rate of heat transfer to the indoor air (if the solar absorptivities of the two materials are the same) and an increase in the time lag. In all cases, low solar absorptivity of the outside surface will *decrease* both the *daily* rate of heat transfer and the *maximum* rate of heat transfer. Time lag, however, is not influenced by a change in solar absorptivity, alone.

After finding the thermal resistance and the value of $k\rho c$ of the simple, homogeneous wall or roof which is the thermal equivalent of the composite construction, the temperature of the inside surface and the contribution to the cooling load at any time of day may be found precisely as if the composite construction were a simple, homogeneous material. A complete summary of the work on periodic flow of heat through homogeneous and composite constructions will be given in a later paper.

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# Mercury Vapor Exposure in the Mercury Thermometer Industry†

By Harry Heimann*, M. D., and K. Leo Dennis*

MERCURY is the only metal which is liquid at ordinary room temperatures; its melting point is −38.87 C (−38 F).[1] The vapor pressure of mercury is such that it evaporates readily at room temperature. Thus, at 20 C (68 F) it has a vapor pressure of 0.0013 millimeters, and at 30 C (86 F) a vapor pressure of 0.0029 mm of Hg.[2] Henderson and Haggard[3] calculated that, under certain conditions, the concentrations of mercury in air produced by metallic mercury would be 1.84 ppm at 20 C, and 4.10 ppm at 30 C. Both of these figures of air concentration are far and above that considered as a safe working atmosphere for continued exposure. Goodman[3] has shown that even at 3 per cent of equilibrium, at temperatures between 20 and 25 C (77 F), the air concentrations of mercury vapor evolved from metallic mercury exposure to air would be above estimated safe maximal concentration, 0.025 ppm. It is thus obvious that when metallic mercury is exposed to the air of a workroom, the air breathed by the workers will contain appreciable amounts of mercury vapor.

Since the exposure to mercury vapor in mercury thermometer plants is due to that vapor which rises from mercury spilled on the floors and work-benches and tables, all measures for decreasing the air concentrations should be aimed at those sources of contamination. The following measures are recommended as a result of this consideration:

*Avoidance of Mercury Spillage*

1. The transfer of mercury from demijohns, or other containers, to the vacuum units for the purpose of filling the glass capillary, should be done with extreme care to avoid the spilling of any mercury.

2. Greater care, than is now taken, should be given to the handling of the capillaries after they are filled with mercury so that less breakage will occur.

3. Earthenware receptacles should be provided at points of breakage so that the broken parts can be deposited in them. These should have water in them and should be tightly closed.

*Housekeeping*

1. All spilled mercury on the floors or work-benches should be collected as soon after it is spilled as is possible. It would be desirable to have this done immediately after the spillage occurs. Collection of this spilled mercury should be done by the use of vacuum into a central container.

*Construction of Workrooms*

1. All work tables and chairs should be covered with an impervious material. This material should be of such nature that cuts and scratches in its surface will be difficult of attainment with the tools used in the industry.

2. All work floors should be covered with an impervious material whose nature should be as described in 1.

3. All floors should be tilted at a slight angle so that mercury spilled on the floors would tend to collect in one common trough which should be kept covered.

4. Work chairs and tables should be so constructed that no mercury will accumulate at the junction of the legs of these furnishings and the floors.

5. In older workrooms in which mercury thermometers have been manufactured for a long time, it may be necessary to remove old floor and base boards to collect all accumulated mercury before constructing new floors.

*Prevention of Mercury Vaporization*

1. Capillary filling operations should all be done by mechanically created vacuum.

2. All containers of mercury should be kept closed unless in actual use.

3. The temperatures of the workrooms are to be kept at as low a level as is commensurate with comfortable working conditions.

4. The floors and work tables should be oiled or sprayed with a wettable sulphur compound[4] daily, following their vacuum cleaning.

*Ventilation*

1. Local ventilation (by negative pressure) by the use of hoods should be present in all locations where containers of mercury are uncovered. Face velocity of 150-200 fpm should be maintained.

2. General ventilation of the down draft type is advisable. The air should come in near the ceiling and be drawn out of the room at or near the floors.

3. Recirculation of air is not to be permitted unless an efficient absorbing agent for mercury such as an iodized charcoal filter is installed in the system.

*Eating Facilities*

1. Eating of lunch at the work tables should not be allowed. A separate room should be set aside for this purpose.

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†Extracts from article in *Monthly Review*, Division of Industrial Hygiene and Safety Standards, New York State Department of Labor, March 1, 1946, Vol. 25, No. 5.

*Division of Industrial Hygiene and Safety Standards, New York State Department of Labor, 80 Centre St., New York 13, N. Y.

[1]Handbook of Engineering Fundamentals, by O. W. Eshbach (John Wiley and Sons, New York, 1936).

[2]Noxious Gases, by Yandell Henderson and H. W. Haggard (Reinhold Publishing Co., New York, 1943).

[3]Mercury Poisoning, by C. Goodman (Rev. Sci. Instr., Vol. 9, p. 233, 1938).

[4]New Process for Controlling Mercury Vapor, by M. Randall and H. B. Humphrey (Bureau of Mines, I. C. 7206, 1942).

# The Effect of Turbulence Promoters on Heat Transfer Coefficients for Water Flowing in Horizontal Tubes

By Lawrence G. Seigel,* Cleveland, Ohio

This paper is a result of research work at Case School of Applied Science at the instigation of the Air Conditioning Section, Bureau of Ships, Navy Department

**SUMMARY—Data are presented in this paper to show the effect of turbulence promoters on heat transfer coefficients for water flowing inside horizontal tubes. Film coefficients for water at low Reynolds numbers in the laminar region are also reported. A discussion is included on the effect of the pressure drop of turbulence promoters and on their application to practical heat exchangers.**

## Introduction

TURBULENCE promoters or retarders have been used for some time to increase the rate of heat transfer from a given amount of surface. However, little information has been available on the relative merits of the various types of devices which have been used. Colburn and King[1] have given data on turbulence promoters for air flowing inside 2⅝ in. steel tubes and somewhat similar data, though not so complete, have been given by Royds[2] for 2 5/32 in. tubes. Nagaoka and Watanabe[3] have investigated the use of turbulence promoters with water flowing in 1 in. pipes, but no information was found for liquids in small diameter tubes. Data are lacking also on film coefficients for water flowing in the laminar region at low Reynolds numbers.

This investigation was undertaken to establish accurate information in regard to the increase in heat transfer and pressure drop which would result from the use of some of the common turbulator designs in ⅝ in. outside diameter copper tubes. *All the data covered by this paper are for heating water at low temperatures in horizontal copper tubes of ⅝ in. outside diameter.* Therefore, they may be applied directly to heat exchangers similar to chilled water cooling coils.

## Test Methods and Procedure

Since the results of this study were to be applied directly to air cooling coils using chilled water as a refrigerant, it was thought best to study the effect of the turbulence promoters in samples of actual coils operating under typical load conditions. Accordingly, a full size air conditioning coil was obtained for the purpose. This coil was of the plate fin type with 8 rows of ⅝ in. outside diameter cop-

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[1] Exponent numerals refer to Bibliography.

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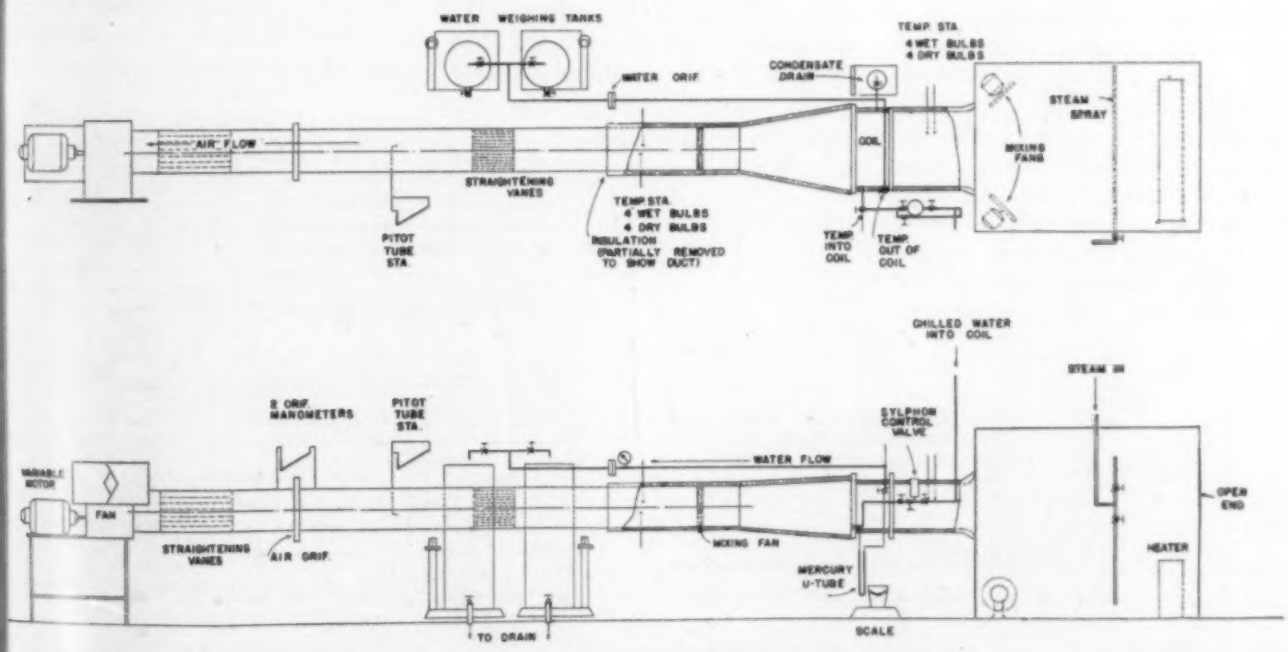


Fig. 1—Setup for Testing Water Coils

per tubes. Water circuiting was arranged as nearly counterflow with respect to the air as possible. Return bends on one end of the coil were soft-soldered so that turbulators could be changed when necessary. The coil was installed in a duct equipped with a preconditioning chamber upstream and a mixing device and air flow orifice downstream as shown in Fig. 1. Air was drawn through the system by a large variable speed blower. Air temperatures were obtained from precision thermometers located at equally spaced points around the duct both upstream and downstream. Four wet bulb thermometers and four dry bulb thermometers were located at each station and readings were taken at intervals of five minutes for at least one hour after equilibrium had been established. The air orifice was calibrated in place by means of a pitot tube. Water quantities were obtained by direct weight and water pressure drop was measured by a mercury manometer connected across the coil headers. Heat balance checks between the air and water showed agreement within plus or minus 5 per cent for all tests and for most tests showed agreement within plus or minus 2 per cent.

In order to isolate the effect of the turbulence promoters in these tests, film coefficients of heat transfer were evaluated for the water side of the coil. The method used in calculating these coefficients was based on principles set forth in another paper[4], and the calculations were extremely tedious because of the fact that it was necessary to analyze the coil performance on a row-by-row basis. No complete computation for any test will be given here because of the extreme length of such an example. Tests of the free tubes (i.e., tubes without turbulators) and of three types of turbulators were run and calculated by these methods, but because of the procedure and calculations involved it was decided that some simpler method of obtaining comparative data on film coefficients should be found.

For this purpose two 10 ft lengths of ⅝ in. outside diameter refrigeration tubing, connected by a return bend, were arranged in a low voltage electrical circuit as shown in Fig. 2. The current used in the tube was varied from 50 to 800 amperes depending on the water quantity flowing in the tube. Tube temperatures were measured by thermocouples attached to the tube and water temperatures were determined by matched precision thermometers. The thermocouples were soldered to the outside surface of the tube after preliminary checks proved that this method of attachment gave consistent results with other methods such as inserting the couples in saw cuts or peening them in the tube surface. The tube was placed in a box and covered with expanded mica for thermal insulation. The electrical current input was measured but no attempt was made to use this data to calculate heat quantities because of the high electrical losses occurring in the connections. For determining coefficients from this setup, heat transfer was based on the water quantity times its temperature difference and the temperature drop from tube to water was taken as the arithmetic mean between the tube and water. The temperature drop through the tube wall was neglected since this amounted to less than 0.02 Fahrenheit degrees in most cases.

### Heat Transfer Results

Fig. 3 shows a correlation of all heat transfer test data for free tubes. This includes data obtained by use of both experimental setups described. Agreement of points obtained by use of these two setups is significant since the calculation procedures used to evaluate the coefficients were different for each test method. In the full scale coil tests no surface temperatures were measured and the tube to water temperature differences were determined on the basis of a computed surface temperature. Agreement of these coefficients with the results of the tests in which surface (or tube) temperatures were measured indicates that the *computed surface temperatures are reliable.* This is important because any coil performance calculation procedure using true film coefficients as basic data must also be capable of evaluating satisfactory surface temperatures for the application of these coefficients.

Fig. 3 also shows agreement with other investigators as indicated by the dotted line in the turbulent region. In the laminar region few data for water in horizontal tubes are available for comparison. In general the correlation of this paper for laminar flow is about 60 per cent above the accepted line for oils which is shown by the lower solid line in Fig. 3. Fair agreement was

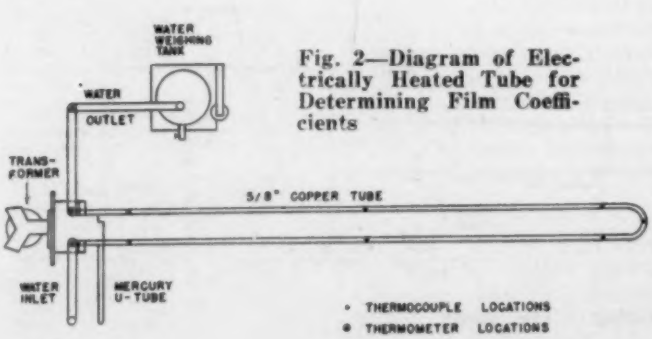


Fig. 2—Diagram of Electrically Heated Tube for Determining Film Coefficients

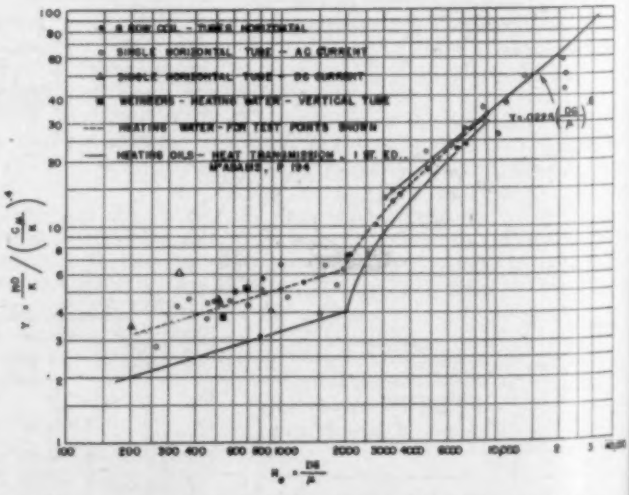

Fig. 3—Correlation of Heat Transfer Data for Water Flowing Inside Pipes

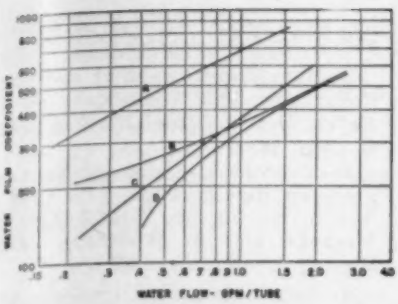

Fig. 4—Comparison of Water Film Coefficients for ⅝ in. O.D. Copper Tube with Various Types of Promoters

A—Steel spiral, ⅜ in. pitch, 12 gage wire; B—Twisted copper strip, 3 in. pitch, 0.02 in. thick; C—⅝ in. copper tube, sealed ends; D—Free tube

obtained with the data of Weinberg[5] for water flowing upward in vertical tubes. However, only two points calculated from Weinberg's data had sufficiently low Reynolds numbers to show on the curve.

Since the coefficients in the laminar region seemed high, two questions arose as to the accuracy of the test procedure. First it was thought that the alternating current used for heating the tube might have set up vibrations which increased the turbulence. This was checked by substitution of direct current for some tests but no significant change of coefficient was found. Results calculated from the data of these check tests are indicated by triangles in Fig. 3. Next it was noted that the tube temperature at the bend was inconsistent during laminar flow and it was assumed that the bend might have caused an increase in turbulence in the second ten foot tube. This was investigated by removing the bend and returning the water to the second tube by exactly the same piping arrangement by which it entered the first. Coefficients were then calculated for each tube separately and agreement with the points of Fig. 3 was still obtained.

It would be desirable to determine coefficients for oils with this setup to see if the cause for disagreement lies in the method or in the evaluation of the properties of the fluid. One other possible cause for the disagreement in the laminar region may be the fact that no calming sections were used before the tubes in these tests although they have been commonly used by other investigators.

A comparison of the coefficients obtained for the free tubes with those obtained by use of various types of turbulators is shown in Fig. 4. (The turbulators used in tests are shown in Fig. 5) These results have been plotted against gallons per minute per tube instead of Reynolds number because of the difficulty of evaluating the Reynolds number when the turbulators were used. Test points have been omitted from these curves to avoid confusion. However, the points are shown in Fig. 6 for the spiral type turbulators in comparison with the free tubes.

Since the spiral springs similar to type A in Fig. 5 showed the best results, several sets of this type were tried. This was done to determine the effect of the distance between turns on the heat transfer coefficient and the pressure drop. No change in heat transfer coefficient could be found when the distance between turns was varied from 3/16 in. to ¾ in. However, the pressure drop decreased with increased spacing. In an effort to obtain the optimum spacing for low pressure drop with maximum heat transfer, tests are being continued to determine what maximum spacing between turns may be used.

## Pressure Drop

While it may be possible to correlate pressure drop and heat transfer to determine the *best turbulator for a given heat exchanger*, no general correlation can be made which applies to all exchangers. In some cases the pressure drop of the connecting piping may be extremely large compared with that of the heat transfer equipment and, therefore, an increase of several hundred per cent in equipment pressure drop may not be excessive. However, other cases may permit only slight increase in pressure drop of the equipment before pumping costs rise beyond savings of space and equipment. Complete details of this pressure drop will be given in a subsequent paper.

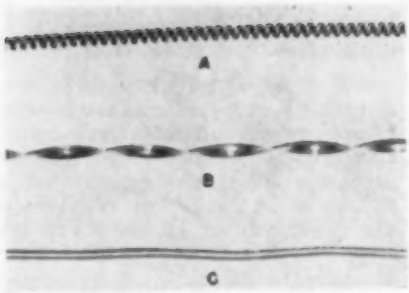


Fig. 5—General Types of Turbulators

A—Spiral spring type, various pitches and wire diameters; B—Twisted copper strip 0.02 in. thick, 3 in. between twists; C—⅝ in. copper tube with sealed ends

## Conclusions

From the results of this investigation the following items may be concluded:

1. The data presented are in fair agreement with those of other investigators but more work by others for water in laminar flow would be desirable to check the results presented here. While practical water quantities are usually well within the turbulent region, occasions may arise when laminar flow exists and adequate data therefor should be available.

2. The method of calculating coil performance by evaluating a surface temperature as suggested in reference 4 is satisfactory since heat transfer coefficients determined by use of this method are consistent with

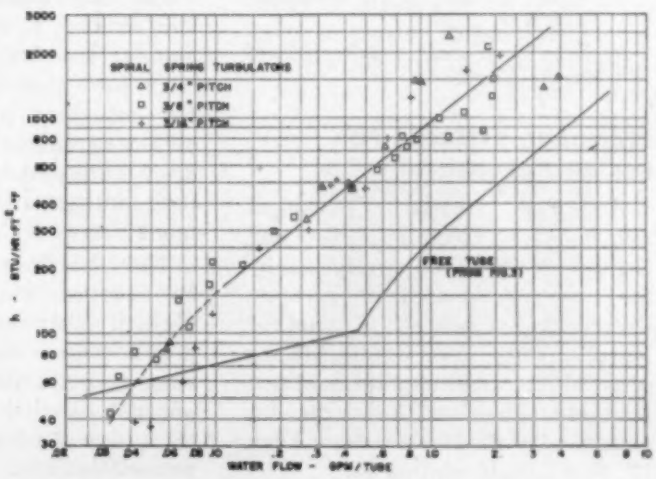


Fig. 6—Effect of Spiral Spring Turbulators on Heat Transfer Coefficients

those obtained by other calculation methods and by other investigators.

3. The use of turbulence promoters increases heat transfer at the expense of pressure drop. This increased pressure drop is localized within the heat exchanger and therefore may not be serious when considered in terms of the pressure drop of the entire system.

4. Spiral spring turbulators like type A of Fig. 5 are of simple construction and their use results in a large increase in heat transfer rate. More work is required, however, to establish the proper ratio of coil spacing to wire diameter.

5. The use of turbulence promoters should be studied in direct expansion systems as well as in systems using other fluids.


### Acknowledgments

Thanks is extended to Prof. G. L. Tuve for his constructive criticism and helpful suggestions and to the following members of the research staff of Case School of Applied Science who performed the tests and carried out the details of calculations: R. K. Ehrenfeld, S. R. Rubin, and R. D. Mandt.


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## MODEL LAW APPROVED

The amendments to the Model Law for the Registration of Professional Engineers and Land Surveyors and Providing for the Certification of Engineers-in-Training, which were drafted at the conference on August 28, 1945, including the new definitions of *Professional Engineer* and *Practice of Engineering*, have been approved and endorsed by the following engineering organizations:

*American Association of Engineers*
*American Institute of Consulting Engineers*
*American Institute of Electrical Engineers*
*American Institute of Mining and Metallurgical Engineers*
*American Society of Civil Engineers*
AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
*American Society of Mechanical Engineers*
*Illuminating Engineering Society*
*National Council of State Boards of Engineering Examiners*
*National Society of Professional Engineers*
*Society of Naval Architects and Marine Engineers*

## STANDARD SYMBOLS FOR USE IN DRAWINGS

American Standard Graphical Symbols for Electric Power and Control Z 32.2-1946, prepared by the ASA Sectional Committee on Graphical Symbols and approved March 1, 1946, is now available for distribution and may be obtained from the *American Standards Association*, 70 E. 45th St., New York 17, N. Y., at 40 cents a copy.

## R. W. CHRISTIE NOW RESEARCH ENGINEER

Robert W. Christie, member of the Society for the past few years, has been appointed research engineer for Air Devices, Inc., New York. Mr. Christie was formerly connected with the U.S. Testing Co., Hoboken, N.J. In his new position he will direct the research and development of filters, diffusers, exhausters, hot water generators and oil fired hot gas generating furnaces. He is also a member of the *ASRE* and *ASME*.

## SENSITIVE GAS DETECTION INSTRUMENTS

Two new instruments, more sensitive for detecting the presence of gas or smoke than any ever devised, have been developed at Northwestern University, where they were invented during the war in connection with the development of gas masks.

The instruments, according to Prof. Robert K. Summerbell, chairman of the department of chemistry, have tremendous possibilities for important peacetime uses, in both research and industrial fields. They were developed under a wartime contract with the National Defense Research Council.

The *Northwestern Ultraviolet Photometer*, developed by Drs. Irving J. Klotz and Malcolm Dole, professors of chemistry, is a rugged, portable instrument with unusual sensitivity for detecting the presence of gases by means of ultraviolet light. It can discover as little as one part of gas in a million parts of air.

Equipped with an automatic recording attachment, it is expected to find considerable use in providing continuous measurement of toxic vapors in factories and mines. It may replace chemical analysis of gases in closed systems, according to Dr. Klotz, for it does not affect the substances analyzed. During the war the photometer was used to detect the penetration of poison gas through masks, to measure the effects of gas bombs in buildings and fortifications and in field tests on the movement of gas clouds.

Another instrument, so sensitive it can detect 1/100,000th of an ounce of smoke in a room 30 feet square, was developed by Dr. Hugh B. Pickard, Frank T. Gucker, Jr., professor of chemistry, and Chester T. O'Konski, electronics expert. Called the *Northwestern Photoelectric Smoke Penetrometer*, the device gives instantaneous readings on the amount of dust in the air. A puff of cigarette smoke diffused in a huge auditorium will deflect its indicator. Its delicate electronic circuits must be hermetically sealed to insure accuracy.

The instrument can be used in studies of industrial plants, smoke elimination, air purification and conditioning systems. The scientists will also employ it in studying the concentration of various colloidal systems in the field of pure chemical research. During the war the instrument was used to test the effectiveness of gas mask filters for toxic smokes at the Northwestern laboratory of the NDRC chemical warfare division.

## CHARLES F. HAUSS, CHARTER MEMBER, DIES

It is with deep regret that the Society learns of the death of Charles Frederick Hauss, one of the two last Charter Members, on May 27th, at the age of 76, at California, Ky.

Mr. Hauss was born September 13, 1869, at Cincinnati, Ohio, where he received his elementary education and attended the Technical Night School, Ohio Mechanics Institute.

He began his long career in the heating field with M. R. Conway in Cincinnati, as draftsman, designing installations; was employed with Love & Co., Heating and Refrigerating Contractors; Oliver Schlemma, Heating and Plumbing Contractor; and John Grossius & Sons, Heating and Air Heating Contractors. In 1893 he became associated with the Richmond Stove Co., Norwich, Conn., four years as New York manager and later as special European representative; then was employed as European representative of Herendeen Mfg. Co. until 1902, when he became representative for the American Radiator Co. in Europe, sales manager of the French subsidiary, Italian subsidiary, special representative in the Far East and finally representative in Belgium, where he retired in 1931 and moved to Milan, Italy.

Mr. Hauss was the youngest Charter Member of the Society. He was intensely active during his fifty-two years' membership in the Society's welfare and progress and did outstanding work in promoting the foreign membership. While in Italy, he translated a paper, "The Temporary Warming of the Large Hall of the Royal and Imperial Palace Library, Vienna, Austria for the Visit of His Imperial Highness, The Crown Prince of Germany, April 14, 1901," by Prof. Edward Meters, of the Imperial Technical High School, Vienna. This paper was presented at the Society's Annual Meeting, January, 1902, at New York City and was published in Vol. VIII TRANSACTIONS for 1902.

Charles F. Hauss

At the tenth Annual Meeting of the Society in 1904, two papers, "The Metric System" and "To Figure Heating Work Accurately—With a Table Showing the Losses in British Thermal Units for Various Surfaces," were presented, which he had prepared at Antwerp, Belgium; they were published in Vol. X TRANSACTIONS for 1904.

In 1931 Mr. Hauss was elected to Life Membership. When the International Congress for Technical Education met in Rome, December, 1936, Mr. Hauss and Mr. Aldo Gini of Milan were selected as the representatives of the Society to attend. A report of this congress was published in the Journal April, 1937.

After his return to the United States in 1940, Mr. Hauss lived at California, Ky., until the time of his passing. He was instrumental in the organization of other professional societies and was honorary life member of the *Japanese Association of Heating Engineers*, now the *Society of Domestic and Sanitary Engineering*.

The Council and Officers extend to his family their heartfelt sympathy in their loss.

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## WILLIAM NELSON HADEN, ESQUIRE, LIFE MEMBER, PASSES

Word has just been received at the Society's headquarters of the death of William N. Haden, Arnolds Hill, Trowbridge, Wiltshire, England, on April 28th, at the age of 87.

Mr. Haden was born on March 10, 1859, at Trowbridge, England. He received his education at Oakley House, Reading and Trowbridge School of Art. In 1875 he began his apprenticeship with the firm founded by his grandfather, G. N. Haden & Son, mechanical heating and ventilating engineers and in 1882 became partner of the firm G. N. Haden & Sons. In 1919 he became the first Chairman of Directors of this firm, then known as G. N. Haden & Sons Ltd., which position he held until his retirement in 1933.

In 1902 Mr. Haden became a member of the Society and in 1929 was elected to Life Membership. He was presented with a gold medal by the *Institution of Heating and Ventilating Engineers* at a special luncheon in London, England, on February 8, 1945, in recognition of his valuable service for 40 years, including 33 years as Honorary Treasurer; President of the English Institution and representative for many years on International Standardization Committees for copper pipe and pipe threads, malleable fittings and iron pipe threads. The medal was inscribed February 8, 1943, but presentation was delayed because of the war. Although in the last few years he was not able to be active in the work of the Society, his great interest remained.

He was Chairman of the Bench. County Councillor, Chairman of the Governors of the High School and held other posts of honor in the community where he lived.

The Council and Officers of the Society join with the many friends of Mr. Haden in extending their deep sympathy and condolence to the family.

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## W. C. GREEN, LIFE MEMBER PASSES

William C. Green, life member of the Society, died in Cincinnati on February 28, at the age of 83.

He was born August 26, 1862, at Rochester, N.Y. where he received his elementary education and attended Cornell University at Ithaca, N. Y. From 1885 to 1894 he was in business for himself selling apparatus for heating plants, designing and erecting plants; the following four years he was employed

W. C. Green

with Henry R. Worthington, as Cincinnati agent, and since 1897 until 1943, when he retired, he was employed with Warren Webster & Co. and the American Engineering Specialty Co. at Cincinnati.

Mr. Green has been a member of the Society since 1906 and was elected to life membership in 1933. He was very active in Society affairs, being instrumental in bringing many new members to its roll. In 1943 he was honorary chairman at the Society's Annual Meeting at Cincinnati.

The Council and Officers of the Society join with the many friends in extending to his family condolences and deepest sympathy in the loss of the companionship of Mr. Green.

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## WILBUR F. SMITH DIES

Word has just been received at headquarter's office in New York that Wilbur F. Smith, member of the Philadelphia Chapter of the Society, died in Philadelphia on January 20th at the age of 64.

Mr. Smith was born at Philadelphia, Pa. January 22, 1882, where he attended the Manual Training School and the University of Pennsylvania. He was employed as draftsman with Keystone Watch Case Co.; for 12 years he was engineer with Frank C. Roberts & Co., consulting engineers, and in 1915 until time of his death was consulting engineer for Wm. M. Anderson, contractor. He was a member of the Engineers Club in Philadelphia and has been a member of ASHVE for over 25 years.

The Officers and Council of the Society extend their deepest sympathy to the members of his family.

## THOMAS JEFFERSON DUFFIELD DIES

The Society learns with deep regret of the death of Thomas Jefferson Duffield, who passed away, at the age of 58, on May 15 in New York City after several months' illness.

A native of Pennsylvania, he was graduated from MIT and in 1919 became health officer at Summit, N. J. During World War I he

T. J. Duffield

served as Major, Sanitary Corps, U. S. Army. Upon his return from service he was chief statistician, Rockefeller Commission for the Prevention of Tuberculosis; instructor, vital statistics, School of Public Health, Harvard University; field epidemiologist, health section, League of Nations, Geneva, Switzerland; research statistician, health demonstrations, Milbank Memorial Fund; executive secretary, New York State Commission on Ventilation; statistician, Metropolitan Life Insurance Co.; and from 1935 until the time of his death was registrar, vital records, New York City Department of Health.

Mr. Duffield became a member of the Society in 1927 and was executive secretary of the Committee on Research. He was also a member of the New York Academy of Medicine, the *American Public Health Association* and the *American Statistical Association.*

Surviving are his wife, Mrs. Kathleen Duffield; a son, Thomas J. Duffield, Jr.; his mother, Mrs. Martha Banks Duffield; two brothers, Leroy B. and Harry Duffield, and two sisters, Mrs. Howard Hurlick and Mrs. R. M. Cox.

Funeral services were held at the Episcopal Church of the Ascension in New York City, Friday, May 17.

The Council and Officers of the Society extend to the family their deepest sympathy in their bereavement.

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## IRA R. CUMMINGS PASSES AT 46

The headquarter's office has just learned that Ira R. Cummings died suddenly of a heart attack on April 20, in Cranford, N. J.

Mr. Cummings was born in Joliet, Ill., September 26, 1899, and received his B.S. degree in Electrical Engineering from the University of Illinois. He has been employed with Danforth Co., Pittsburgh, as erection and service engineer and design and estimating engineer. Later he became associated with the Westinghouse Electric & Mfg. Co. in Cleveland, and at the time of his death was with the Westinghouse Electric Elevator Co., Jersey City, as precipitron application engineer.

He was a member of the Society and was affiliated with the New York Chapter.

The Council and Officers of the Society extend to his widow, Mrs. Margaret F. Cummings, residing at 717 Willow Street, Cranford, N. J., and the family their heartfelt sympathy in their bereavement.

# SUMMARY OF LOCAL CHAPTER MEETINGS*

ATLANTA—April 27. The Spring Outing of the Atlanta Chapter was held at Monroe Gardens. A barbecued chicken dinner was served from the outdoor grill and after dinner the group went into the large stone play room for square dancing. For most of the members and guests square dancing was a new art, but with a professional leader to instruct and call the figures and the unmistakable square dance rhythm provided by a string quartet, they caught on quickly. Attendance, 128.

ATLANTA—April 12. Subject: Insulation and Vapor Sealing in the Low Temperature Field. Speaker: E. T. Cope, Detroit Edison Co., Research Department. The talk indicated that insulation of heating pipes and ducts above atmospheric temperatures was well standardized, the chief considerations being the use of preshrunk covering and good workmanship during installation; however, the insulation of surfaces at sub-atmospheric temperatures presented a more difficult problem because of the need for vapor sealing. The talk was fol-

lowed by an interesting discussion period. Attendance, 60. Attendance ratio, 0.37.

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CENTRAL NEW YORK—April 24. Subject: Location and Installation of Registers, Fan Circulation, Correct Setting of Controls. Speaker: John W. Morris, Lennox Furnace Co., Inc. The speaker gave a very interesting talk on air circulation for the residential system and the correct and incorrect method of setting of controls for continuous operation of the blower. He stated that circulation should be continuous throughout a building to reduce temperature differential between floor and ceiling when the outside temperature reached 45 deg; by having continuous blower operation on the winter air conditioning system *cold 70* was eliminated and the result was an even temperature and velocity distribution throughout the building. Attendance, 303.

•

CENTRAL OHIO—April 15. Subject: Electronic Air Cleaning. Speaker: W. L. Gabbert, Louisville, Ky. The subject was very interesting and very well presented. Attendance, 45. Attendance ratio, 0.64.

•

CINCINNATI—April 9. Subject: Radiant Heating. Speaker: Prof. F. W. Hutchinson, Purdue University, Lafayette, Ind. Professor Hutchinson gave the members and guests some real information on the subject of radiant heating, holding the attention of his audience for an hour and a half. A very active discussion followed the talk. Attendance, 103. Attendance ratio, 0.72.

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CONNECTICUT—April 17. Subjects: Steam Distribution and Control in Heating and Baseboard Heating. Speakers: H. F. Marshall and C. G. Binder, Warren Webster Co., Camden, N. J. Both of the talks were illustrated and augmented by samples of the various materials described. A vote of thanks was extended the speakers for the very interesting presentation of their subjects. Attendance, 72.

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DELTA—May 1. Subject: Pipe Wall Thickness. Speaker: O. W. Page, U. S. Maritime Commission. Mr. Page received a rising vote of thanks for the very informative talk, which was followed by a question and answer period. Attendance, 18.

•

GOLDEN GATE—April 9. Subject: Temperature Control. Speakers: Frank Hook, Johnson Service Co., and Reginald Cushing, Minneapolis-Honeywell Regulator Co. Mr. Hook gave a brief history of the development of temperature control and the possibility of adapting it to the many different types of air conditioning systems. He gave examples of the application of thermostats, automatic and manual, to the control of dampers supplying an air conditioning unit. The importance of static pressure regulation and of the proper sizing of steam and hot water valves was emphasized. Mr. Cushing discussed panel heating and its controls and modulating heating control for houses and small commercial buildings. He illustrated his talk with charts. Attendance, 58. Attendance ratio, 0.58.

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ILLINOIS—April 8. Subject: Air Distribution Through Perforated Plates and Panels. Speaker: M. J. Stevenson, consultant engineer, Industrial Multi-Vent Div., Pyle-National Co., a member of Illinois chapter. Mr. Stevenson illustrated his talk with a chart presentation and traced the development of the method, showed a number of installations and detailed the design and operating features. A demonstration model permitted actual readings of air flow. Attendance, 135. Attendance ratio, 0.75.

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INDIANA—April 5. At the invitation of Prof. W. T. Miller, the members were invited to Purdue University, where they visited engineering points of interest. After dinner Professor Miller introduced the speakers and their subjects. George Springmeyer, Research Progress in Housing; William Chapman, Radiant Heating; F. W. Hutchinson, Solar Heating. The afternoon and evening at the University were profitable and enjoyed by all who attended. Attendance, 97. Attendance ratio, 1.4.

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MASSACHUSETTS—April 16. Subject: Control of Building Systems by Outside Type Programming Devices. Speaker: H. T. Kucera, Weather Controls Division, Automatic Devices Co., Chicago, Ill. An interesting discussion followed the presentation of the subject. Attendance, 62. Attendance ratio, 0.795.

MASSACHUSETTS—March 29. The regular meeting of the chapter was dispensed with in favor of a ladies' night card party. Attendance, 40. Attendance ratio, 0.51.

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MEMPHIS—April 9. Subject: Influence of Aviation and Automotive Heat Transfer Surface Development in the Heating and Air Conditioning Field. Speaker: L. P. Saunders, member of Committee on Research. Mr. Saunders illustrated his talk with slides, which was most interesting. Attendance, 21. Attendance ratio, 0.66.

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MICHIGAN—April 15. Subject: Fan Sound Levels and Selection. Speaker: Thomas A. Walters, a member of Michigan Chapter. After an interesting question and answer period Mr. Walters was accorded a hearty vote of thanks for his interesting talk. This meeting was designated as Past Presidents' Night. There were 16 past presidents in attendance. President Connell traced the history of the chapter from its inauguration in 1916 to the present time and introduced the past presidents who were invited to rise and take a bow. Attendance, 83. Attendance ratio, 0.62.

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MINNESOTA—April 2. Subject: Magic in Electronics. Speaker: Gordon Volkenant, new products research engineer, Minneapolis-Honeywell Regulator Co. The subject was most interestingly presented by the speaker, who had a number of electronic devices to demonstrate. President Gorgen introduced R. W. Evans and H. A.

Paine, members recently returned from military service. Attendance, 60. Attendance ratio, 0.28.

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NORTH TEXAS—Subject: The Building and Livability of a 100 Year House. Lynn Landrum of the Dallas Morning News was chairman of the informal discussion of the subject, directing questions from the layman's point of view to a panel of experts, consisting of G. L. Dahl, representing the architects; Leo Landauer, representing the mechanical engineers: H. J. Martin, representing the plumbing and heating contractors; and Glen Wasson, representing the electrical industry. Attendance, 66. Attendance ratio, 1.73.

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OKLAHOMA—May 13. Subject: The Application of Modulating Controls to the Small Heating System. Speaker: J. H. Spaan, Jr., J. M. Connor Co., Oklahoma City. Mr. Spaan's talk was received with considerable interest. Attendance, 22. Attendance ratio, 0.53.

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ONTARIO—May 6. This meeting was devoted entirely to Chapter business, committee reports, etc. Attendance, 94. Attendance ratio, 0.50.

ONTARIO—April 5. Subject: Salesmanship. Speaker: Ray Crowell, President, Rowe Paint and Varnish Co. This was a joint meeting of the Ontario and Western New York Chapters. Herman Seelbach, Jr. occupied the chair during the afternoon's proceedings, which were begun with the showing of a sound slide film depicting the various types of heating available today. The film was enthusiastically received. It emphasized the seven keys to comfort and, among other things, the importance of comfort in the home and obtaining the services of a reputable heating contractor. A feature of the meeting was the attendance of several husbands and wives, outside the industry, who stated just what they would like in heating and presented questions. Brief talks were given on the following subjects: the principles of the hot water system, by Mr. Lambert; gravity warm air, by James Mitchell; radiant and solar heating, by J. D. Ross (all of Toronto); the forced hot water system, by E. Willcott; the fundamentals of forced warm air, by Myron Beaman; the steam system, by Sherman Strouse (all of Buffalo). The meeting was then opened for discussion. V. J. Jenkinson presided at the banquet and evening session. Attendance, 97.

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OREGON—May 9. Subject: Alaska. Speaker: J. Donald Kroeker. After the regular chapter business and introduction and installation of new officers, Mr. Kroeker presented a very interesting illustrated lecture based on his Alaska travels while in the service. Attendance, 46.

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NORTHERN OHIO—April 8. Subject: Axial Flow Fans, Their Design and Application. Speaker: Mr. Hagen, Director of research, B. F. Sturtevant Co., Div. of Westinghouse. Mr. Hagen gave a history of the development of the axial flow fan and its use by the U. S. Navy, outlined the design theory, the use and limitations. An active discussion period indicated the interest created by the speaker and the audience rose en masse applauding an appreciated talk. An added feature of the evening was a brief talk on the U.N.O. by G. F. Albrecht of the Council on World Affairs. Attendance, 110. Attendance ratio, 0.76.

NORTHERN OHIO—March 11. Subject: Radiant Heating. Speaker: Prof. F. W. Hutchinson, Purdue University. Professor Hutchinson gave an understandable explanation of the theory in the use of radiant heating and described the research program under way at Purdue University in radiant and solar heating. A very active discussion period followed. Dr. Shepard Whitman, director of the Council on World Affairs gave a brief talk on the needs, purpose and organization of the Council. Attendance, 154. Attendance ratio, 1.10.

NORTHERN OHIO—February 11. Subject: Industrial (Sanitary) Ventilation Problems. Speaker: Dr. Allen D. Brandt, senior engineer, U.S. Health Service, now stationed at the Society's Laboratory. An active discussion followed a very interesting talk. Mr. Earl Snyder, of the Council on World Affairs gave a brief talk on the U.N.O. Attendance, 75. Attendance ratio, 0.53.

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PACIFIC NORTHWEST—April 11. Subject: Radiant and Reversed Cycle Heating. Speaker: Prof. Louis Slegel, mechanical department, Oregon State College. Attendance, 21.

PACIFIC NORTHWEST—March 12. Subject: Radiant Heating. Speaker: George Guler, Minneapolis-Honeywell Regulator Co. Much interesting information was brought out in discussing the subject, especially in the part dealing with radiant heat control. Attendance, 31.

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PHILADELPHIA—April 11. Subject: The Attack on Virus Infection Through Air Conditioning. Speaker: D. G. Lindsay, Air and Refrigeration Corp., New York, N. Y. A great deal of interest was shown by the members at the discussion period after the talk. Attendance, 60.

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ST LOUIS, MO.—April 8. After the regular chapter business, talks were given by visiting Council members and Society officers as follows: A. J. Offner, president, *What Your Society is Doing Today;* Prof. G. L. Tuve, 2nd vice-president, *Bright Spots and Blind Spots in ASHVE,* with particular emphasis being placed on the free spirit of ASHVE as displayed at meetings; L. P. Saunders, vice-chairman, Committee on Research, *Research and Industry;* John F. Collins, Jr., treasurer, *Special Studies on Weather Statistics & Heat Requirements of Buildings;* Cyril Tasker, director of research of the Society and Prof. F. W. Hutchinson, a member of the Committee on Research, gave brief talks on the activities and plans for the future of the Laboratory. A short general discussion period was conducted by Mr. Tasker. Attendance, 55.

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SOUTH TEXAS—April 19. After the chapter business two moving pictures were shown, one entitled, *Eternal*

*Yours* (the story of wrought iron), and the other, *There is an Engineering Reason*. Attendance, 56.

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SOUTHERN CALIFORNIA—April 10. Subject: The Relation of Air Conditioning to Vegetable Physiology. Speaker: A. J. Hess, Hess-Greiner and Polland, Los Angeles. According to Mr. Hess, apparently very little air conditioning of greenhouses has been done up until recent years. The present greenhouses are not used for producing plants, but only for experimentation and development. Plants require different temperatures during the night than they do during the day and the interesting phenomenon was also pointed out that plants do their growing during the night rather than during the day, *i.e.*, the action of the sun tends to stimulate osmosis through the plant and at night a pressure is developed within the plant producing growth. The speaker cautioned that a great deal of experimentation is yet to be done in this field for air conditioning. Attendance, 40.

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UTAH—May 8. Subject: Steel Production at Geneva. Speaker: C. L. Wagoner, Supervisor of Raw Materials and Superintendent of Blast Furnaces at Geneva Steel Co. The speaker related the procedure followed in the production of steel and the problems involved in starting up a plant the size of Geneva. He stated that Geneva Steel has a capacity of over one million tons of steel ingots per year; it obtains all its raw materials from Utah, Nevada and Colorado. The meeting was opened for discussion after a most interesting talk. Attendance, 26. Attendance ratio, 0.56.

UTAH—April 17. Subject: Electronics—Magic of War and Peace. Speaker: Gordon Volkenant, Coordinator, New Products Research, Minneapolis-Honeywell Regulator. Co. The speaker gave a brief history of the development of the electronic tube from its discovery to its present highly developed state. He very ably and entertainingly told his audience of the important part electronics played in the recently concluded war and how thousands of lives were saved through this development alone. Mr. Volkenant's talk was very well received as evidenced by the questions from the group which followed the formal presentation. President Young, in behalf of the members, thanked the speaker for the very interesting talk. Attendance, 47. Attendance ratio, 0.61.

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WASHINGTON, D.C.—April 10. Subject: District Heating. Speaker: J. F. Collins, Jr., Pittsburgh, Pa., treasurer of the Society. After a very interesting talk a question and answer period followed. Attendance, 44. Attendance ratio, 0.33.

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WESTERN NEW YORK—April 5. This was a joint meeting of the Western New York and Ontario chapters. The general chairmen were, V. J. Jenkinson for the Ontario Chapter and Herman Seelbach for the Western New York Chapter. In the afternoon a *Domestic Heating Clinic* was presented which covered fully the requirements for the various types of heating systems in domestic use today. Three of the Buffalo chapter members and three of the Toronto chapter members defined the various methods of heating such as gravity, warm air, forced warm air, etc. This clinic was very well attended and many interesting and enlightening questions and answers were put forth. A cocktail hour preceded the dinner held in the ballroom of the Hotel Niagara. Roswell Farnham, Buffalo, acted as toastmaster. R. T. Crowell of Niagara Falls gave a short, but lively, talk on salesmanship. Attendance, 97.

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WISCONSIN—April 15. Subject: Psychology and the Thermostat. Speaker: F. C. McIntosh, Johnson Service Co., Pittsburgh. The speaker, in discussing the temperatures in air conditioning for comfort, stressed the fact that there are two kinds of human reactions; physiological reactions which are related to the structure of body and psychological reactions which govern the movement of the body. A lively discussion followed his remarks and a rising vote of thanks was extended Mr. McIntosh for his interesting talk. Attendance, 50. Attendance ratio, 0.59.

WISCONSIN—March 18. Subject: Dust and Dust Collectors—Today's Industry and Fly Ash Problems. Speaker: H. O. Danz, manager, Dust Collector Division, American Blower Corp., Detroit. The speaker outlined the various types of dust collection problems encountered in industry and pointed out the microscopic size of the dust particles which have to be collected, many of which range from 10 to 20 microns. Mr. Danz presented a number of slides illustrating the various types of collectors which he had discussed in his talk and a number of questions were brought up and answered by him. A rising vote of thanks was extended the speaker. Attendance, 51. Attendance ratio, 0.60.

WISCONSIN—February 20. Subject: Reactions to the Kilgore Bill. Speaker: B. K. Brown, vice president, in charge of research and development, Standard Oil Company of Indiana. Mr. Brown, a witness before the Senate Committee who recommended the bill, stated that there seemed to be, at the moment, little danger to industry and it was probable that the recommendations of the Office of Scientific Research and Development, looking toward the control of scientific achievement for war and nothing else, will be the ultimate end of forthcoming legislation. This was the second annual joint meeting of the Wisconsin Chapter ASHVE and the Engineers' Society of Milwaukee. At the speaker's table were O. A. Trostel, president, Wisconsin Chapter, John Potts, president, *ESM*, Prof. G. L. Larson, past president of the Society and Ernest Szekely, member of the Society's Council. Attendance, 388. Attendance ratio, 4.60.

WISCONSIN—January 21. Subject: Industrial Ovens and Industrial Drying. Speaker: F. H. Faber, vice president and director of sales, Despatch Oven Co. The speaker covered applications of industrial ovens in three groups, drying, baking and heating. An extremely interesting discussion followed Mr. Faber's talk, and he was given a rising vote of thanks. Attendance, 41. Attendance ratio, 0.48.

# CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 82 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by July 10, 1946, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ALLAN, JAMES E., Principal, Hunt & Allan. PROPOSERS: W. J. Killian, W. D. Ehlers. SECONDERS: W. W. Shuster, H. K. Jennings.

ATKINSON, WILLIAM J., Dept. Mgr., Winnipeg Supply & Fuel Co., Ltd. PROPOSERS: F. T. Ball, J. R. Stephenson. SECONDERS: Einar Anderson, D. S. Swain.

BAILEY, MURRAY C., C. A. Dunham Co., Ltd. PROPOSERS: F. W. Stott, W. R. Blackhall. SECONDERS: H. D. Henion, C. D. Seymour.

BARTELS, EVERETT M., Supvsr. of Mech. Equip., Independent School District. PROPOSERS: Perry La Rue, F. E. Triggs. SECONDERS: C. H. McGuiness, C. A. Wheeler. *(Advancement)*

BEECRAFT, GERALD A., Partner, Atlas Air Conditioning Co. PROPOSERS: E. P. Root, F. R. Bishop. SECONDERS: W. O. Smith, R. C. Champlin.

BEGGS, PHILIP B., Sales Engr., Paul W. Beggs & Son. PROPOSERS: T. C. Douglass, G. M. Simonson. SECONDERS: G. D. Martin, James Gayner.

BISHOP, ALVIN C., Supt., Sheet Metal Div., D. F. Edwards Heating Co. PROPOSERS: H. C. Sharp, W. J. Oonk. SECONDERS: H. A. Grossman, E. T. Clucas.

BROADWALL, HAROLD W., Applica. Engr., York Corp. PROPOSERS: J. A. Walsh, R. F. Taylor. SECONDERS: H. C. Will,* A. M. Chase, Jr.

BRUCE, LEWIS E., Mgr., Skelgas Htg. Dept., Skelgas Div. of Skelly Oil Co. PROPOSERS: P. C. Leffel, D. M. Allen. SECONDERS: R. B. Mason, Henry Gould.

BUCK, WILLIAM H., Refrigerating & Power Specialties Co. PROPOSERS: F. L. Nemec, W. W. Cockins. SECONDERS: W. P. Scott, Jr., H. V. Hickman.

CONNOR, WILLIAM A., Service Engr., Page-Hersey Tubes Ltd. PROPOSERS: W. J. Usher, Jr., J. H. Ross. SECONDERS: V. J. Jenkinson, W. H. Evans.

CRAWFORD, JAMES N., Sales Mgr., Bryant Heater Co. PROPOSERS: H. W. Heisterkamp, L. C. Harvey. SECONDERS: Gayle Priester, J. L. Frisse.

DODGE, RAYMOND V., Jr., Design Engr., American Viscose Corp. PROPOSERS: James Breakell*, L. H. Pownall*. SECONDERS: J. M. Richardson*, F. E. Maddox*.

DROEGKAMP, CALVIN F., Pres., Calvin Droegkamp Heating Co. PROPOSERS: H. K. Pride, J. R. Vernon. SECONDERS: H. W. Schreiber, M. M. Herrick.

EVERT, MARTIN C., Secy., Alexander-Stafford Corp. PROPOSERS: T. D. Stafford, O. D. Marshall. SECONDERS: H. D. Bratt, W. W. Bradfield.

FLOETER, ELLIOTT G., Jr., Sales Engr., Way Engineering Co. PROPOSERS: D. M. Mills, W. J. Way. SECONDERS: Norman Way, C. C. Quin.

GERHARDT, EMERSON D., The Glenn L. Martin Co. PROPOSERS: W. K. Ebel,* H. C. Wirben, Jr.* SECONDERS: W. B. O'Neal,* K. R. Smythe.*

GREGORY, KEGHAM S., Engr., York Corp. PROPOSERS: J. A. Walsh, A. M. Chase, Jr. SECONDERS: H. C. Will,* J. C. Lewis.

HARPER, EVERETT C., Applica. Engr., York Corp. PROPOSERS: W. J. McKinney, M. M. Crout. SECONDERS: P. E. Seepe, L. F. Lawrence, Jr.

HARRIS, VICTOR J., Partner, Service Plumbing & Heating Co. PROPOSERS: J. L. Frisse, Dennis Boggs. SECONDERS: J. M. Black, William Silk.

HEAD, FREDERICK T., Consolidated Edison Company of New York, Inc. PROPOSERS: A. F. Hinrichsen, J. C. Yorden.* SECONDERS: C. W. Hartman, A. A. Pihlman.*

HEARNE, RUFUS D., Sales Mgr., Air Cond. Div., Wagner Engineering and Service Co. PROPOSERS: D. W. Davis, Jr., H. K. Pride. SECONDERS: I. J. Haus, F. W. Goldsmith.

HEATHCOTE, HENRY J., Mech. Engr., Carrier Engineering Co., Ltd. PROPOSERS: M. E. Mooney, H. G. Strong. SECONDERS: C. M. Ashley, A. Silvera.

HICKMAN, CHARLES W., Htg. Engr., Thermazone Co. PROPOSERS: K. O. Alexander, Robert Bruen. SECONDERS: R. C. Cushing, H. V. Hickman.

HOLMAN, ROBERT F., Office Supvsr., American Radiator & Standard Sanitary Corp. PROPOSERS: W. J. McKinney, L. F. Lawrence, Jr. SECONDERS: M. S. Hamilton, A. H. Koch.

HOLT, WHEELER M., Div. Mgr., B & B Engineering & Supply Co., Inc. PROPOSERS: Frank Skinner, J. C. Lewis. SECONDERS: E. H. McLane, C. L. Boehler.

HORSBURGH, ALBERT E., Pres., Control Equipment Co., Ltd. PROPOSERS: T. H. Worthington, S. W. Salter. SECONDERS: J. J. Cosgrove, T. E. Cockman.

HOTZE, VINCENT, Owner, Hotze Heating Co. PROPOSERS: H. K. Jennings, G. V. Sutfin. SECONDERS: A. H. Gerdsen, A. W. Edwards.

IBISON, JAMES L., Applica. Engr., Ralph B. Johnson & Co. PROPOSERS: R. F. Taylor, D. S. Cooper. SECONDERS: A. F. Barnes, R. B. Johnson *(Advancement)*

IRWIN, CONRAD P., Jr., Mech. Engr., J. R. Bracewell & Associates. PROPOSERS: W. J. McKinney, P. E. Seepe. SECONDERS: L. F. Lawrence, Jr., A. H. Koch.

KAENTER, RICHARD J., Htg. Engr., St. Louis Skelgas Co. PROPOSERS: H. C. Sharp, L. R. Szombathy. SECONDERS: W. D. Thompson, G. B. Rodenheiser.

KINDAID, JOHN R., Sales Engr., Dravo Corp. PROPOSERS: C. F. Eveleth, A. F. Manno. SECONDERS: L. H. Pogalies, E. J. Sable.

KNIPE, WILLIAM E., Owner, William E. Knipe Sales & Service. PROPOSERS: W. L. Dulle, H. C. Sharp. SECONDERS: R. L. Wolf, C. H. Burnap.

LAGOW, ATWELL C., Engr., Leo L. Landauer & Associates. PROPOSERS: J. A. Ray, L. S. Gilbert. SECONDERS: G. A. Linskie, J. A. Bishop.

LARSON, CARL W., Engr., McQuay, Inc. PROPOSERS: H. B. Williams, C. L. Bensen. SECONDERS: E. H. Seebert, R. J. Resch.

LEGGETT, REGINALD J., Plbg. & Htg. Contractor. PROPOSERS: A. M. Peart, A. B. Madden. SECONDERS: S. W. Salter, J. G. Chenevert.

LINDEMAN, CLAUDE F., Owner, Claude F. Lindeman Plumbing & Heating. PROPOSERS: I. W. Cotton, E. C. Keim. SECONDERS: G. B. Supple, T. R. Davis.

LIPPITT, A. WARREN, Engrg. Draftsman, Robert E. Hattis. PROPOSERS: C. W. Johnson, J. J. Philippi. SECONDERS: H. J. Prebensen, H. C. Gotschall.

LUX, ALEX C., Asst. Supt., Steam Htg. Dept., Puget Sound Power & Light Co. PROPOSERS: C. W. May, A. L. Pollard. SECONDERS: S. D. Peterson, M. N. Musgrave.

LYONS, HUBERT W., Engr., Sharpe & Dohme, Inc. PROPOSERS: H. G. Black, M. F. Blankin. SECONDERS: H. H. Erickson, C. F. Wietz.

MCCOY, FLOYD F., Owner, Floyd F. McCoy Heating Co. PROPOSERS: L. G. Miller, C. H. Pesterfield. SECONDERS: F. R. Bishop, G. A. Voorhees.

MERICLE, CLIFFORD D., Assoc. Editor, Air Conditioning & Refrigeration News. PROPOSERS: T. H. Mabley, S. S. Sanford. SECONDERS: C. F. Donohoe, M. B. Shea.

MOLE, HUGH W., Engr., Norton Co. PROPOSERS: H. R. Roth, G. E. Brua. SECONDERS: W. G. A. Barr, William Philip.

MOLLOY, EDWARD J., Jr., Student, University of California. PROPOSERS: B. F. Raber, E. G. Thomsen.* SECONDERS: C. F. Garland,* J. A. Putnam.*

MURRAY, JOSEPH E., Office Engr., G. M. Richards & Assocs. PROPOSERS: H. V. Hickman, G. M. Simonson. SECONDERS: R. C. Cushing, C. L. Peterson.

MUTIMER, A. G., Dist. Mgr., B. F. Sturtevant Co. PROPOSERS: Ludwig Mack, G. P. Dickson. SECONDERS: C. W. Schmidt, E. C. Lambert.

OPPENHEIMER, PHILIP H., Cons. Engr. PROPOSERS: H. E. Ziel, J. N. McBride. SECONDERS: G. W. A. Steinmetz, Philip O'Keefe.

PATERSON, W. B., Sr. Mech. Engr., Department of National Defense. PROPOSERS: A. B. Madden, R. P. Allsop. SECONDERS: A. M. Peart, S. M. Peterkin (*Reinstatement & Advancement*)

PLAYER, FRANK A., Mgr., Branch Office, Mehring & Hanson Co. PROPOSERS: W. J. McKinney, L. F. Kent. SECONDERS: J. J. O'Shea, S. W. Boyd.

POTIER, OSCAR N., Partner, Marques & Monteiro Ltd. PROPOSERS: C. G. Alves,* A. D. Lindley.* SECONDERS: D. P. deMoura,* I. Hasson.*

PRESSLER, J. D., Head of Design & Engrg., A. M. Strauss. PROPOSERS: W. R. Sinish, E. H. Hattersley. SECONDERS: W. L. Davis, H. V. Alexander.

QUACKENBUSH, JOHN M., Partner, Quackenbush Co. PROPOSERS: Herman Seelbach, Jr., M. C. Beman. SECONDERS: S. W. Strouse, S. M. Quackenbush.

RAMSEUR, VARDRY D., Jr., Partner, V. D. Ramseur & Sons. PROPOSERS: T. H. Smoot, Frank Parker. SECONDERS: James Waldrep, G. R. Morgan. (*Advancement*)

REICH, HERBERT H., Mech. Engr., Power Piping Div., Blaw-Knox Co. PROPOSERS: T. F. Rockwell, C. M. Humphreys. SECONDERS: Cyril Tasker, G. W. Cost.

RESS, OTTO J., Research Dir., L. J. Mueller Furnace Co. PROPOSERS: H. K. Pride, I. J. Haus. SECONDERS: F. W. Goldsmith, E. W. Gifford. (*Advancement*)

RICHMOND, GEORGE B., Mgr., Cooling & Vent. Dept., Hunter Fan & Ventilating Co. PROPOSERS: Oliver Holmes, J. B. Lammons. SECONDERS: T. J. O'Brien, A. T. Bevil.

ROCHE, GEORGE J., Pres.-Treas., Roche & Hull, Inc. PROPOSERS: P. J. Vincent, Harvey Hottell*. SECONDERS: J. J. Murphy*, Clarence Hottell*.

ROWE, WILLIAM M., Field Engr., American Blower Corp. PROPOSERS: D. L. Taze, H. E. Sproull. SECONDERS: T. A. Walters, R. W. Dickson, Jr. (*Advancement*)

RYAN, FRANK J., Mgr. & Supvsr., William D. Ryan. PROPOSERS: John Barrett,* G. A. Frecker.* SECONDERS: R. S. Furlong,* W. J. Ryan.*

SALAUN, HAROLD L., Comm'l. Supvsr., New Orleans Public Service Inc. PROPOSERS: J. M. Guillory, F. G. Burns. SECONDERS: J. S. Burke, G. E. May.

SCHMIDT, JACK F., Student Engr., Carrier Corp. PROPOSERS: J. H. Carpenter, W. A. Grant. SECONDERS: F. B. Neyhart, J. P. Stewart.

SCHOENHERR, EDGAR J., Mech. Engr., Department of Public Works. PROPOSERS: Bernard Stotesbury, W. B. Pennock. SECONDERS: J. P. Fitzsimons, L. A. Hood.

SEIBERT, EARL W., Pres., Advanced Refrigeration Co. PROPOSERS: H. K. Jennings, L. L. Kuempel. SECONDERS: R. W. Sigmund, W. B. Cooper.

SENK, EDMUND P., Engrg. Draftsman, Robert E. Hattis. PROPOSERS: C. W. Johnson, J. J. Philippi. SECONDERS: H. J. Prebensen, H. C. Gotschall.

STAMPS, HAROLD F., Field Engr., Henry Valve Co. PROPOSERS: J. J. Philippi, C. M. Burnam, Jr. SECONDERS: C. W. Johnson, G. G. Turner.

SVOBODA, GEORGE J., Lab. Engr., McQuay Inc. PROPOSERS: H. B. Williams, C. L. Bensen. SECONDERS: E. H. Seelert, R. C. Colman.

SZOMBATHY, ALFRED R., Sales Engr., Ferguson Sheet Metal Works, Inc. PROPOSERS: L. R. Szombathy, W. A. Bemis. SECONDERS: A. R. Niemoeller, M. F. Carlock.

TEJEDA, SALVADOR M., Cons. Engr. PROPOSERS: R. N. Gomez,* J. J. Martiney.* SECONDERS: C. H. B. Hotchkiss, Rudolf Kuhlmann.

TEMPLETON, H. J., Southwestern Dist. Merchandise Mgr., American Blower Co. PROPOSERS: J. A. Bishop, M. W. Brown. SECONDERS: I. I. Bock, V. G. Cox.

TEUBER, HARRY N., Sales Engr., Warren Webster & Co. PROPOSERS: E. K. Webster, C. G. Binder. SECONDERS: L. H. Plum, Warren Webster, Jr..

THOMPSON, QUENTIN P., Sales Engr., Minneapolis-Honeywell Regulator Co. PROPOSERS: S. W. Strouse, H. Seelbach, Jr. SECONDERS: F. A. Moesel, W. R. Heath.

THOMPSON, ROBERT E., Engr., International General Electric Co., Inc. PROPOSERS: F. L. Maggini,* D. W. McLenegan. SECONDERS: R. U. Berry, F. O. Urban.*

TRAYNOR, JOHN H., Sales Engr., Johnson Service Co. PROPOSERS: N. W. Downes, W. L. Cassell. SECONDERS: F. A. Sheppard, Carl Clegg.

ULOVEC, HENRY F., Asst. Secy. & Chief Engr., Mehring & Hanson Co. PROPOSERS: R. A. Lowe, Leo Hungerford. SECONDERS: R. M. Storms, R. J. Petersen.

VAN EPPS, HAVERLY H., Precipitron Engr., Westinghouse Electric Corp. PROPOSERS: A. H. Blaker, S. R. Lewis. SECONDERS: E. P. Heckel, S. I. Rottmayer.

WALKER, W. STOCKTON, Asst. Control Dir., Consolidated Edison Company of New York, Inc. PROPOSERS: C. H. Flink, N. T. Sellman. SECONDERS: H. S. Birkett, E. D. Milener.

WARREN, OLIN A., Mech. Engr., Robson & Woese, Inc. PROPOSERS: P. D. Robson, H. K. Ormsby, Jr. SECONDERS: C. F. Woese, W. H. Driscoll.

WHITACRE, VERNE L., N. Y. Dist. Mgr. of Insulation, Johns-Manville Sales Corp. PROPOSERS: W. A. Sherbrooke, W. E. Heibel. SECONDERS: C. S. Koehler, H. J. Ryan.

WHITT, SIDNEY A., Chief Engr., Cordley & Hayes. PROPOSERS: C. E. Scott, E. R. Walker. SECONDERS: R. W. Morgan, A. F. Dietz. (*Advancement*)

YANCEY, FOSTER V., Air Cond. Engr., Atlanta Gas Light Co. PROPOSERS: M. W. Wise, Boynton Cole. SECONDERS: J. A. Sheahan, L. F. Kent.

YANCEY, RICHARD H., III, Applica. Engr., Advanced Refrigeration, Inc. PROPOSERS: G. R. Bilderback, R. F. Hahn. SECONDERS: W. J. McKinney, P. E. Seepe.

YATES, ERNEST F., Cons. Engr., Reg. F. Taylor. PROPOSERS: R. F. Taylor, R. J. Salinger. SECONDERS: C. S. Woodruff, R. H. Wittbold.

*Non-member.

# CANDIDATES ELECTED

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. of the By-Laws, the following list of candidates elected:

## Members

ADAMS, THOMAS K., Dept. Mgr., Reunert & Lenz Ltd., Johannesburg, South Africa.

ARKLEY, KENNETH L., Designing Draftsman, Ecusta Paper Corp., Pisgah Forest, N. C.

BARRY, JAMES, Jr., Elliott & Barry Engineering Co., St. Louis, Mo. (*Reinstatement*)

BRYAN, WILLIAM L., Jr., Research Engr., York Corp., York, Pa. (*Advancement*)

DAVIS, LESTER T., Project Mgr., Standard Engineering Co., Inc., Washington, D. C.

DEBES, CHARLES N. Owner, Charles N. Debes & Assoc., Rockford, Ill.

EMERSON, EDWARD K., Engr., Swift & Co., Chicago, Ill.

EWENS, F. G., Toronto, Ont., Canada. (*Reinstatement*)

FARMER, JERRY E., Pres., The Saxet Co., Inc., Dallas, Tex.

HAINES, FRANK H., Vice-Pres., Standard Engineering Co., Inc., Washington, D. C.
HENRIKSEN, HARVEY E., Indus. Project Engr., General Controls Co., Glendale, Calif.

JOHNSON, WILFRID E., Mgr. of Engrg., General Electric Co., Bloomfield, N. J.

KEARBY, EARL J., Mgr., Air Cond. Dept., Cahn Electric Co., Shreveport, La.
KENDRICK, GEORGE M., Dist. Mgr., American Blower Corp., Minneapolis, Minn.

LINSKIE, GEORGE A., Engr., U. S. Engrg. Dept., Denison, Tex. *(Advancement)*
LONG, ODELL B., Partner, Air Engineering Co., Charlotte, N. C.

MANN, ISHAM W., Jr., Field Service Engr., A. M. Byers Co., New Orleans, La.
MCCALLUM, C. E., Vice-Pres., Piedmont Heating & Air Conditioning Corp., Charlotte, N. C. *(Reinstatement)*
MEEK, GEORGE W., Cons. Engr., Syracuse, N. Y.
MERCER, BLAIR G., Sales Engr., Dallas Air Conditioning Co., Dallas, Tex.
METZLER, CHARLES F., Sr. Draftsman, Austin Engineering Co., Cleveland, Ohio.
MUELLER, JOHN C., Sr. Research Engr., Payne Furnace Co., Beverly Hills, Calif.

OTTER, RAYMOND E., Director, J. S. Wright & Co., Ltd., Birmingham, England.

PINEAU, MAURICE E., Engr., Crane Ltd., Montreal, Que., Canada.

ROBINSON, WILLIAM P., Mech. Engr., P.W.D., N.A.S., U. S. Navy, Norfolk, Va.
RYDEN, ERIC H., Engr., C. A. Olsen Manufacturing Co., Elyria, Ohio.

THOMAS, RALPH C., Pres., Thomas Air Conditioning, Inc., Norfolk, Va. *(Advancement)*

WEYENBERG, HENRY, Chief Engr., Holland Furnace Co., Holland, Mich.

## Associate Members

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**Pacific Northwest:** Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, D. C. Griffin, [illegible] Lloyd Bldg., Seattle 1. Secretary, C. W. Finn, 702 Lloyd Bldg., Seattle 1.

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*For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1946 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.*

### Lightweight Thermal and Acoustical Insulation

**No. 3132—"Fiberglas Superfine PF," a lightweight, noncombustible, thermal and acoustical insulating material has been announced by Owens-Corning Fiberglas Corp., 1842 Nicholas Bldg., Toledo 1, Ohio.**

Developed during the war for use in military aircraft, the material is now offered for installation in civilian aircraft, buses, trucks, railroad cars, and other applications where light weight is of major importance. It is composed of fine glass fibers which are treated with a thermosetting binder and shaped into resilient, flexible, ½ in. thick sheets. Density is 0.6 lb per cu ft and thermal conductivity is 0.26 Btu per sq ft per hr per inch thickness per deg Fahrenheit temperature difference. Moisture absorption is said to be less than one per cent by weight.

Because major use of this material has been in aircraft, the acoustical data now available are based upon aircraft fabrication, but data for other uses and construction are being compiled.

### Rotameter Lighting Device

**No. 3133—An inexpensive lighting device for its new "Universal" rotameter has been introduced by the Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia 22, Pa.**

The device, a baked enamel metal hood with narrow frontal opening, fits against the back of the rotameter tube and directs a beam of light through the glass toward the operator. Thus rotor and meter scale are outlined even when the metered fluid is semi-opaque in character. The lighting unit can be attached to any of the company's 250 mm length universal rotameters by means of a bracket furnished with each device. A push button socket, 10 ft of rubber covered attachment cord and plug are included. It uses a 110 volt tubular incandescent lamp which may be obtained from any electrical supplier.

### Roller Bearing

**No. 3134—Development of a new type of roller bearing capable of carrying heavier loads at higher speeds and lower temperatures has been announced by SKF Industries, Inc., Front St. & Erie Ave., Philadelphia 34, Pa.**

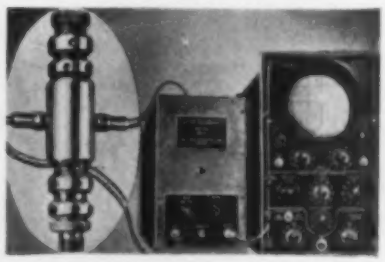
The bearing's self aligning principle, designed to compensate for any shaft deflections, distortions, or weaves, permits heavy loads to be distributed over all rollers and reduces danger of overloading. Because of its compactness, it utilizes less space and is lighter in weight than a plain bearing. The company's production facilities have been tooled to develop preferred sizes for immediate manufacture.

Ability of the new bearing to carry heavy loads at high speeds is said to be possible because of unique design which permits more effective lubrication. Another feature of the bearing is a cage retaining sleeve pressed into the bore of the inner ring, making a contained assembly of the rollers, cage and inner ring. According to the manufacturer, some of the important industrial applications for this spherical roller thrust bearing include pumps, turbines, generators, and other high speed machines.

### Electronic Pressure Indicating Instrument

**No. 3135**—The new "Pressuregraph," brought out by Electro Products Laboratories, 349 W. Randolph St., Chicago 6, Ill., is an electronic instrument which is designed to indicate pressure-time relationships on a cathode ray oscillograph.**

Suitable for indicating the performance of any engine, pump, or other device subject to pressure variations, the unit includes a pick-up which includes a diaphragm. When acted upon by pressure impulse, the diaphragm unbalances an electronic circuit. The unbalanced voltage from the pick-up is amplified and passed through a negative modulation suppressor and then through the oscillograph. The sweep circuit of the oscillograph is adjusted to the speed of the engine under test. A band of light appears on the screen, the contour or shape of which is said to represent the true pressure-time curve.



In addition to dynamic pressure variations, the unit

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Heating, Piping & Air Conditioning, [6-46]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

*(Circle each number in which you are interested)*

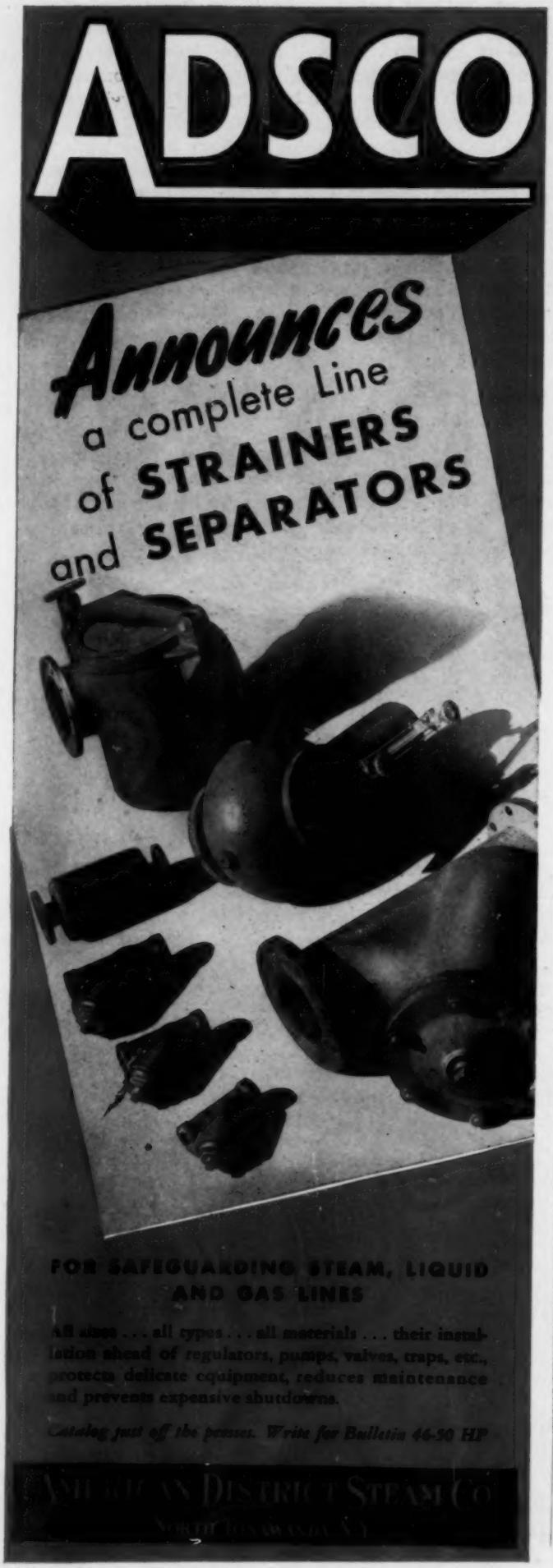
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3132 | 3133 | 3134 | 3135 | 3136 | 3137 | 3138 | 3139 | 3140 | 3141 |
| 3142 | 3143 | 3144 | 3145 | 3146 | 3147 | 3148 | 3149 | 3150 | 3151 |
| 3152 | 3153 | 3154 | 3155 | 3156 | 3157 | 3158 | 3159 | 3160 | 3161 |
| 3162 | 3163 | 3164 | 3165 | | | | | | |
| 6181 | 6182 | 6183 | 6184 | 6185 | 6186 | 6187 | 6188 | 6189 | 6190 |
| 6191 | 6192 | 6193 | 6194 | 6195 | 6196 | 6197 | 6198 | 6199 | 6200 |
| 6201 | 6202 | 6203 | | | | | | | |

Name..... Title.....

Company .....

Address .....

City.....Zone..... State.....

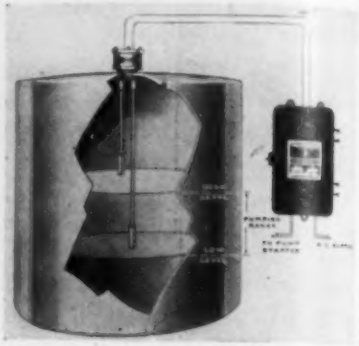

ADSCO
Announces
a complete Line
of STRAINERS
and SEPARATORS
FOR SAFEGUARDING STEAM, LIQUID AND GAS LINES
All sizes . . . all types . . . all materials . . . their installation ahead of regulators, pumps, valves, traps, etc., protects delicate equipment, reduces maintenance and prevents expensive shutdowns.
Catalog just off the presses. Write for Bulletin 46-50 HP

is designed to show static or low pressure variations and to cover all mechanical speeds and pressure variations up to 10,000 psi.

### Liquid Level Control

**No. 3136—The series 10 liquid level control offered by Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass., utilizes stainless steel probe rods to control the level of electrically conductive liquids.**

Said to be the only floatless level control which does not use vacuum tubes and operates with low voltage in the probe circuit, the device consists of probe rods which are suspended in a tank. The liquid to be controlled makes or breaks contact with the probe and transmits to the control a small current at low voltage. This current controls a relay which is used to actuate valves, pumps, or signals.

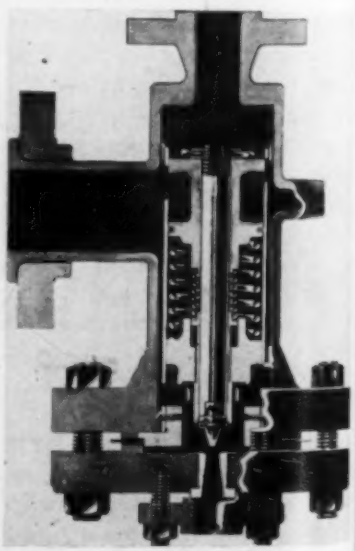


The unit is said to be suitable for controlling the level of water, milk, beer, ammonium chloride, copper nitrate, sodium chloride, potassium hydroxide, and many other acids, bases, and salts. To match the specific resistivity of a material, four terminals are provided on the terminal block. The control is rated at 115 or 230 volts, 50/60 cycles, a-c, and ½ watt power consumption. The relay is single pole, double throw.

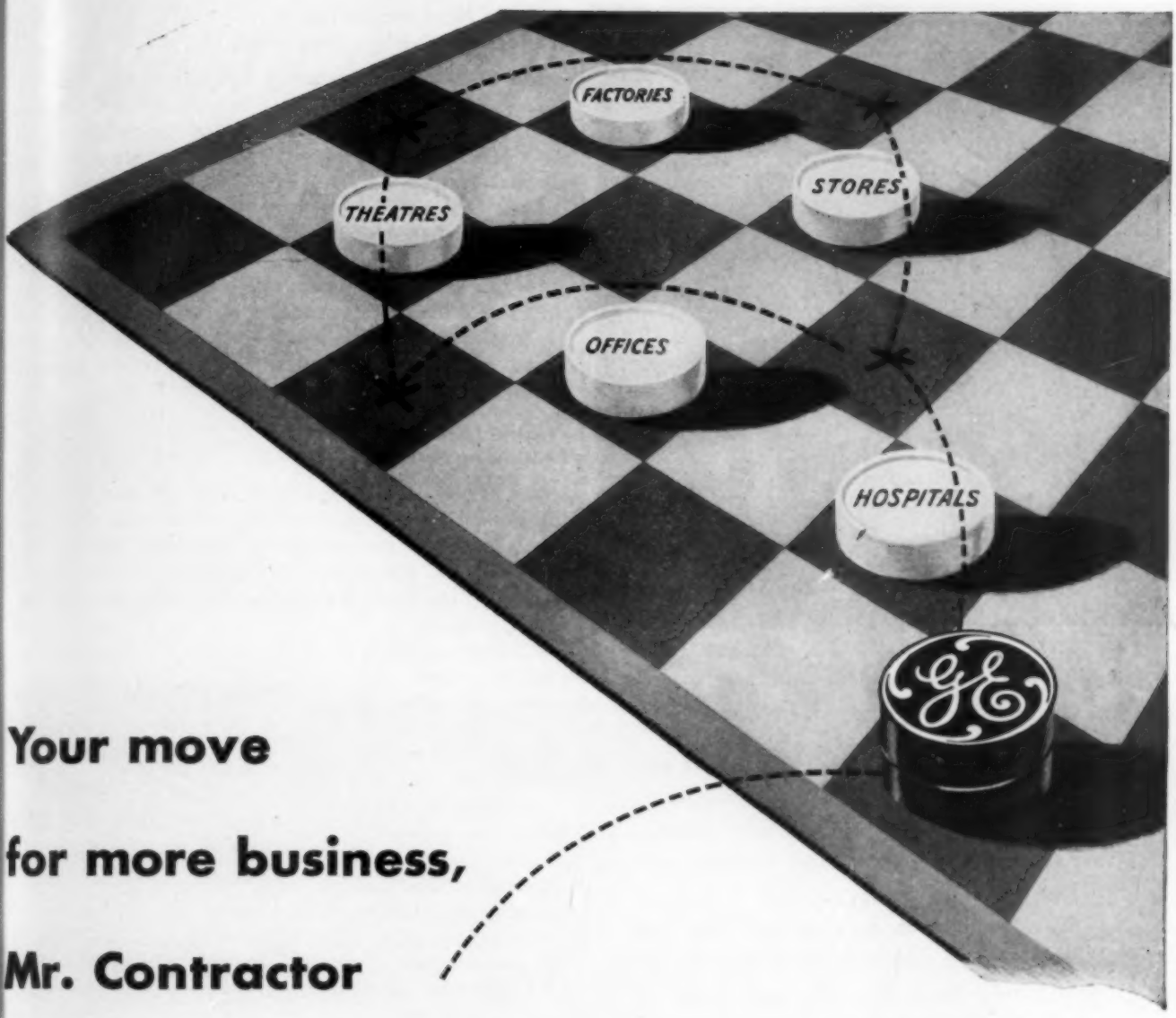
### Bypass Valve to Protect Centrifugal Pumps

**No. 3137*—The Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I., offers a recirculating valve designed to eliminate centrifugal pump failures resulting from insufficient flow of fluid through the pump.**

The unit consists of an automatic recirculating valve operated from the fluid flow and designed to bypass the minimum quantity of fluid required to eliminate pump overheating. As the quantity of fluid passing through the pump increases, the bypass quantity is automatically throttled and is reduced to zero when the output of the pump is sufficient to prevent pump failure.



The valve may be installed in existing pump piping by removing any convenient elbow in the discharge piping upstream of all checks and stops.




# Your move for more business, Mr. Contractor

**TAKE A LOOK AT THE FIGURES.** Experts predict that at least *a billion dollars* will be spent on air conditioning in the next five years. 55% of that amount will come from commercial establishments. 30% will come from industrial applications. Obviously there is a wonderful future for contractors providing the right kind of air conditioning.

**TAKE A LOOK AT THE PROSPECTS.** General Electric is reaching commercial and industrial establishments in your community through advertising in The Saturday Evening Post, Collier's, Time, Business Week and a long list of business papers. These prospects are learning that G. E. gives them *BETTER* Air Conditioning. They're learning, too, that G-E Air Conditioning is worth waiting for.

Put this powerhouse G-E campaign to work for you by contacting your prospects now . . . letting them know you'll be ready to serve them the minute sufficient G-E equipment is available.

*General Electric Co., Air Conditioning Dept., Section 6556, Bloomfield, New Jersey.*

**GENERAL ELECTRIC**

***Complete Air Conditioning***

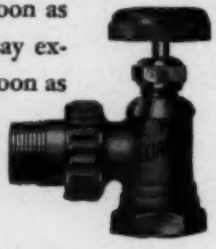
THE HEAT'S ON!

The third degree we're getting for our oldest plumbing items is really "something" (though not exactly like the picture, of course). Plenty uncomfortable, yet kind of flattering, too.

But here's the point . . .

We're anxious to produce the Gate and Radiator Valves we took over just before the war (former Eureka line). But with reconversion of our first few *plumbing items* taking our whole capacity—and still nowhere near enough—you can see why those items still have to be allotted . . . and also why we can't start our new Gate and Radiator Valves right now.

We're as anxious as you are to catch up with customers' needs . . . good service . . . prompt delivery. And, of course, you can count on the famous Eureka Gate and Radiator Valves on that basis as soon as possible. We still can't say exactly *when*. But just as soon as some of the heat is off of us, we can help you turn it on for your customers.



The Schaible Company

CINCINNATI 4, OHIO

MAKER OF QUALITY BRASS GOODS
STOCKED BY LEADING WHOLESALERS EVERYWHERE

### To Build New Plants for Production of Glass Insulation

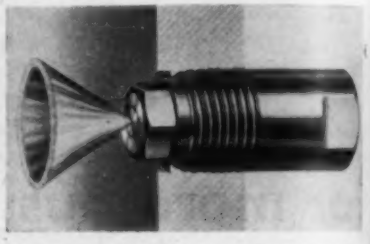
**No. 3138—The Pittsburgh Corning Corp., 632 Duquense Way, Pittsburgh, Pa., has announced plans to build two plants at Sedalia, Mo., for the production of glass block and "Foamglas," a cellular glass insulating material.**

Estimated cost of the expansion program is 2 million dollars, according to J. P. Staples, general manager for the concern. A plant for the production of glass block will be constructed first and facilities for the production of this insulation will be added as soon as building materials and equipment are available. When both plants get into full production approximately 600 persons will be employed.

### Wall Mounted Atomizing Nozzle

**No. 3139*—A new hydraulic type atomizing nozzle for use with water, oil, solvents, and liquids of similar viscosities, and which may be mounted directly into the wall of processing or machine equipment, is offered by the Spraying Systems Co., 4033 W. Lake St., Chicago 24, Ill.**

Made in a variety of materials including brass and stainless steel, the nozzle consists of (1) the body, (2) a cap with stainless steel insert, and (3) a monel metal screen or strainer. The cap and core assemblies are renewable and the units are available in 16 sizes for pressures ranging from 10 to 1000 psi. According to the manufacturer, spray is of the hollow cone type with uniform distribution of the atomized liquid.



### Gas Analysis

**No. 3140—The Davis Emergency Equipment Co., Inc., Newark, N.J., has introduced the new "Davis-Hebler" thermal conductivity cells, together with related methods of gas analysis and other developments including electronic recorders and controllers manufactured by Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., 4534 Wayne Ave., Philadelphia 44, Pa.**

These cells are designed to analyze any one gas in vapor, any one gas in its relation to any other one gas, and with the recorders, the proportioning of any one gas to any other gas, and will analyze any one gas which can be reacted or absorbed out of a complex mixture.

According to the manufacturer, the new cell permits flow rates of 20 to 1000 cc per min without affecting overall readings and no flow gage is required in this system.

The advantages of the new thermal conductivity cells and their recording and controlling elements are said to include the minimizing of the error due to ambient temperature, voltage, or current change, a maximum sensitivity to gas change, the freeing of flow rate sensitivity, elimination of flow gages and

# What's new?

## COMMUNITY SHOPPING CENTERS

### —and the preferred building pipe is still NATIONAL

THIS beautiful new Colonial Shopping Center would be an asset to any community. It is designed as a unit and is to be heated from one central boiler plant.

When an architect designs a project like this, he naturally strives to select materials that will give the most reliable service. The functioning parts of the building must operate with high efficiency and with the least possible maintenance.

In the selection of pipe, this means NATIONAL—for more NATIONAL Pipe has been installed in American buildings than any other brand. It is preferred by architects, owners, contractors, and heating engineers. It gives the most all-round service for the dollars invested.

NATIONAL is the original Spellerized, Scale-Free pipe. The Spellerizing Process produces a uniformly dense surface finish, more resistant to corrosion. The Scale-Free Process eliminates mill scale leaving a clean, smooth surface inside and out. The additional rolling increases the strength of the weld about 20 per cent, making the pipe especially desirable for bending and coiling in radiant heating installations.

NATIONAL Pipe has national acceptance. Such acceptance means that it has been used in hundreds of the nation's most important buildings for plumbing lines, central heating and individual radiant heating systems.

Colonial Shopping Center, Wm. C. Young, Reg. Architect, Pittsburgh, Pa. National Pipe was specified for the complete heating system which operates as one unit.

**NATIONAL TUBE COMPANY**

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*

United States Steel Export Company, New York

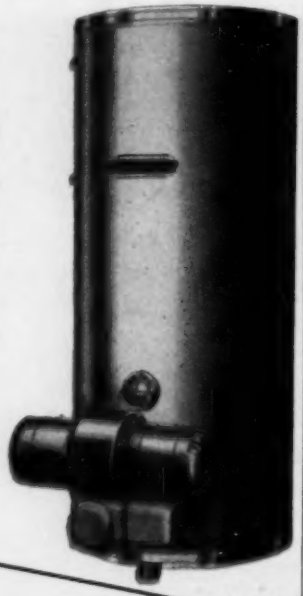
**UNITED STATES STEEL**

**KNOWN and USED THE WORLD AROUND**

Aldrich Oil Burners and Burner-Boiler Units were standard equipment in United States Insular Bases the world around. That's proof of unmatched efficiency, performance . . . All during the war, Aldrich Co. worked night and day at their regular job—producing extra-value burners and burner-boiler units . . . Post war improvements are facts—not promises—in Aldrich equipment.

**HEAT-PAK Burners Models AX and BX**

Embodying famous Aldrich features, HEAT-PAK Model AX (.75 to 5.00 G. P. H.) and Model BX (4.00 to 9.00 G. P. H.) are being produced as fast as materials become available . . . Production of famous HEAT-PAK Burner-Boiler Units and oil-fired Water Heaters is limited only by manpower and materials.



*Aldrich*
COMPANY
WYOMING, ILLINOIS

**SERVICE-FREE**

Aldrich engineering genius, designing skill, and production experience combine to give you equipment that is practically service free. No wonder Aldrich led the industry in prewar volume! Look to Aldrich for leadership in oil-fired equipment.


manometers, and the low operating temperature of the filaments.

### Acquires Right to Hot Water Heating System

**No. 3141*—The Power Piping Div., Blaw-Knox Co., 829 Beaver Ave., Pittsburgh 12, Pa., has taken over, from the J. O. Ross Engineering Corp. of New York, all engineering, sales, fabricating, and installation (in North and South America) of the "Superheram" hot water heating system.**

This system, utilizing superheated water for industrial heating, was originally promoted in Europe where it was used in a variety of industries. In 1935 it was introduced in America by Ross. In the period before the war, many installations were made in prominent plants here.

Among the advantages of the system are said to be the substantial savings it provides in fuel and maintenance costs for, being a completely closed pipe system without traps, pressure reducers, separators, and other steam accessories, it eliminates these sources of heat and flash off losses. For process heating, this hot water system is said to assure more uniform temperatures, even for suddenly added loads, due to the great amount of heat stored in the entire volume of water and due to its forced circulation.

### Dial Type Thermometer

**No. 3142—The Bacharach Industrial Instrument Co., 7000 Bennet St., Pittsburgh 8, Pa., is producing an all metal, dial type thermometer for indicating temperatures from 100 to 950 F.**

As shown in the illustration, it is provided with a slip-on handle designed to protect the operator's hand when the instrument is in portable use. The handle can be detached when the instrument is to be used as a permanently mounted indicating thermometer.

Features of this instrument, says the manufacturer, include quick response to temperature change, all metal construction, a bimetallic temperature element with no pivots, mechanical linkages, or gears. It is said to provide sustained accuracy within 1 per cent of scale range, and is designed to withstand momentary scale temperatures within 10 per cent of scale range.

It is made with a stainless steel stem 3/16 in. OD and 5 in. free length, with 2 in. immersion required to obtain accurate readings, and is also available with 3/8 in. OD stem having 9 in. free length.

### Safety Check Valve For Air Lines

**No. 3143**—A ball type check valve, designed to shut off the flow of air in the event of excessive flow**

caused by accidental disconnecting or rupture in the air line, is being produced by the Hackett Mfg. Co. of Oakland, Calif., and is distributed through E. D. Bullard Co., 275 8th St., San Francisco, Calif.

The unit is designed to eliminate the danger of wildly whipping compressed air hose, to eliminate the practice of crimping hose to shut off air while changing tools, to indicate bad leaks before they can cause damage, and to prevent the use of inefficient tools which waste air. The valve consists of two main parts, a housing and a steel ball which rests between hexagonal ends in a sump at the compressor end of the valve. This sump slopes upward toward the discharge end where there is a machined circular port. Excessive flow of air causes the ball to roll up the slope until it seals off the port. A bleed hole beside the discharge port allows the escape of a small amount of air which equalizes the pressure between the air line and the pressure tank, when the line is again made air tight. When the pressure is nearly equal, the ball drops away from the port and rolls back into the sump.

The unit is available for working pressures up to 250 psi and comes in standard ½ in. and ¾ in. sizes.

### Electric Heater for Ovens and Air Ducts

**No. 3144—A new oven heater, "Chromalox," type NOU modified, has been developed by the Edwin L. Wiegand Co., 7610 Thomas Blvd., Pittsburgh 8, Pa., to operate at temperatures up to 950 F.**

Designed to provide high heating capacity in a small space, the heating element terminals are centralized at one end of the assembly which consists of 14 high temperature chrome steel sheathed strip heaters. End brackets of sheet metal are punched to permit mounting to either the walls or bottom of the oven. The strip heater elements are mounted in the end bracket at a slight angle to the mounting surface to encourage air circulation.

On applications where forced air circulation is employed, the assemblies may be used, with a slight change in the position of the strips, as air duct heaters. To increase heating capacity, any number of assemblies may be mounted in the air duct. The heater is normally 33½ in. long, 28 in. high, and 3 in. deep and is rated as 8 kw at 230 volts; however, both physical dimensions and electrical rating may be altered to suit specific requirements.

### Oil Fired Boiler

**No. 3145**—A horizontal return tube steam boiler, designed for oil firing, has been developed by the Columbia Boiler Co., Pottstown, Pa.**


*Reduce Installation Costs*

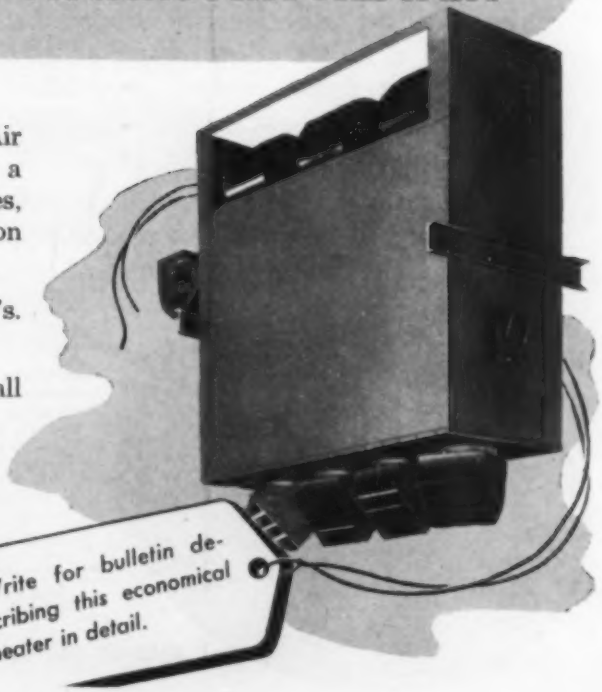
WITH THE LIGHT WEIGHT

AIRTHERM DIRECT-FIRED WARM AIR HEATER

The highly efficient Airtherm Direct-Fired Warm Air Heater is light in weight and may be installed with a minimum of structural expense. Three standard sizes, each in three models: floor mounted, vertical suspension and horizontal suspension.

Nine capacities, from 650,000 to 1,950,000 B.T.U.'s. Either oil or gas fired.

Tests prove efficiencies in excess of 80% on all models.



AIRTHERM MANUFACTURING COMPANY

711 So. Spring Avenue • St. Louis 10, Mo.

Write for bulletin describing this economical heater in detail.

The boiler, which is constructed in accordance with ASME standards and which is suitable for working pressures up to 100 psi, is said to be especially suitable for generating steam for process work. According to the manufacturer, the many features include easy access to the single bank of tubes, a large combustion chamber, two pass updraft, a large steam space, a large heating surface, high efficiency, and completely submerged tubes.

### Hot Water Heating Specialties

**No. 3146*—The Marsh Heating Equipment Co., 2120 Southport Ave., Chicago 14, Ill., has entered the hot water heating field with a line of hot water heating specialties.**

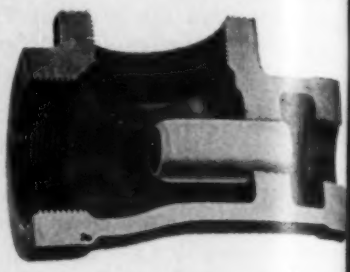
Among the items of equipment which are offered are circulating pumps, flow control valves, air eliminators, supply tees, expansion tanks, indirect heaters, tankless hot water heaters, relief valves, pressure reducing valves, and pressure control units.

The circulating pumps are equipped with 1/6 hp motors and are available in sizes from 1 to 2 in. The flow control valves are of the universal type and may be arranged as either angle, vertical, or horizontal check valves. Relief valves have cast iron bodies and brass working parts and are built to ASME standards.

### Venturi Fitting for Combined Hot Water and Space Heating

**No. 3147—A venturi type fitting, designed to provide positive circulation of boiler water through an attached hot water heater, is offered by Taco Heaters, Inc., 342 Madison Ave., New York City.**

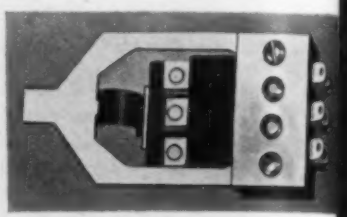
Consisting of a cast iron body and copper venturi jet, the fitting is designed to allow full gravity flow of hot boiler water through the heater when the circulating pump is off. When the circulating pump is on the fitting utilizes the venturi principle to insure flow through the water heater in the right direction. It is said to eliminate circulation in the wrong direction and therefore to eliminate the hazard of cooling domestic water in a tank heater or the non-functioning of a tankless heater.



### Three Pole Snap Action Switch

**No. 3148—A new three pole, open blade snap switch is offered by Acro Electric Co., 1392 Superior Ave., Cleveland 14, Ohio.**

The small switch, 3 in. x 1⅜ in. x ½ in., is made for normally open or normally closed circuits. It is rated at 10 amp at 125 volts, a-c, or 5 amp at 230 volts. Operating pressure runs from 12 to 18 oz for

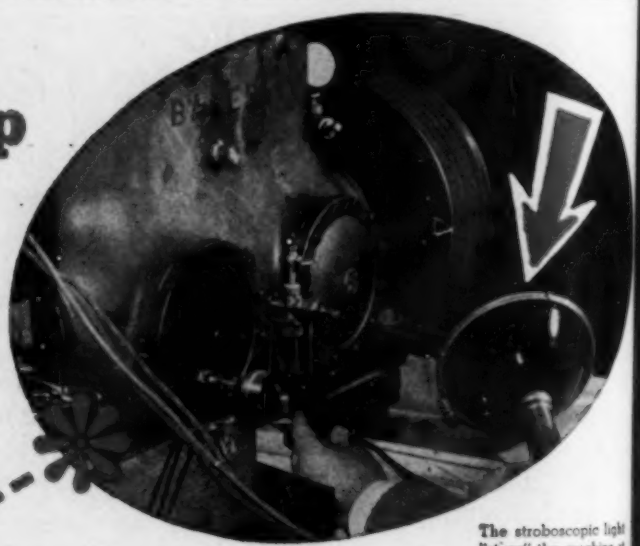



# From Full Speed to a Dead Stop

***—in a millionth of a second!***

The stroboscopic light, used in the Baker Testing Laboratories, "stops" the action of a Baker compressor at any speed. Thus Baker testing engineers can "see" the smallest defect in the machine while it is running at top speed.

Still another of the painstaking tests that make the Baker name mean long life and dependable performance.



The stroboscopic light "stops" the machine at any desired point of the piston's stroke.

Delicate electronic instruments search out defects as small as 1/10,000 of an inch.

Baker

ICE MACHINE COMPANY, INC., OMAHA

MANUFACTURERS OF REFRIGERATION AND AIR CONDITIONING EQUIPMENT SINCE 19

e return type construction and 4 to 8 oz for the set pe construction. According to the manufacturer, tter contact pressure, faster action, and longer life e provided by beryllium rolling spring construction.

### as Burner Manufacturer oves into New Plant

No. 3149**—The Norman Products Co., incorporated in August, 1945, to design gas fired equipment for her manufacturers and for manufacture under its n trade name, has moved into its new plant at 150 Chesapeake Ave., Columbus, Ohio.

"Norgas" conversion burners are now in production in the new plant which occupies approximately 0,000 sq ft of floor area. Both E. A. Norman, Jr., resident, and D. D. Piper, secretary-treasurer and les manager, are well known in the gas appliance nd utility field.

### lectrode Holder

No. 3150**—A new line of manual arc welding electrode holders known as "Twecotong" has been announced by the Tweco Products Co., Wichita 1, Kan. The holder is of the conventional type; however, it atures molded minated glass oth, bakelite inlation keyed to e holder casting. ensioning spring ats on fiber upset washers and is protected from spatter by nonbinding neoprene tubing. A well ventilated fiber handle, together with good cable connection, it is said, assure a cool running holder.

### Cold Water Pipe Insulation

No. 3151**—Mystik Adhesive Products, Div. of Chicago Show Printing Co., 2635 N. Kildare Ave., Chicago 39, Ill., has developed a cold water pipe insulation, "Self-Stik Dri-Pipe," designed to prevent sweating and dripping. The outer backing of the insulation is said to be a moisture proof, resinous coated cloth which prevents dampness from damaging the insulation. The edges of the backing are adhesive so that installation consists of applying the material lengthwise to cover the pipe and overlapping the edges. According to the manufacturer, painting is not required, but the backing will take paint for decorating purposes.

# TALLMADGE ZONED CONTROLLED HEATING SYSTEMS

*For better heating at less cost*

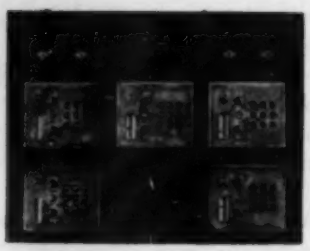


Figure 1

Figure 3

Figure 2

Figure 4

THE TALLMADGE equipment shown above is for a Zoned Heating System, either automatic or remote control (Figure 1). Airotherms, (Figure 2) for outside control, determine the heating requirements and set Pressure Boxes (Figure 3) to regulate the steam pressure to each zone. Orifices (Figure 4) meter the steam entering the radiators.

ADVANTAGES: Precise control of steam. Elimination of over-heating and costly waste of fuel. Low cost of maintenance. Saving on outlay for original equipment. Greater comfort to occupants due to steady heat and modulated even distribution.

**WEBSTER TALLMADGE & CO., Inc. 364 Glenwood Ave., East Orange, N. J.**

**You cut perfect 1" to 2" pipe threads with *least effort* with**

***Precision-built, Self-contained***

**RIDGID**

**No. 65 R**

● If you've never used this remarkable steel-and-malleable No. 65R die stock, you have a pleasant surprise coming. Workholder sets to pipe size instantly, no bushings to fool with—dies adjust to 1," 1¼," 1½" or 2" pipe in 10 seconds! With least possible effort the high-speed steel chasers cut smooth perfect threads on any pipe. It's precision quality in every part. For performance and long life . . . for surprisingly easy threading . . . buy the RIDGID 65R at your Supply House.

RIDGID *No. 65R stands up handily on the floor.*

**RIDGID**

**WORK-SAVER PIPE TOOLS**

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.


The material is made in one size for covering ½ and ¾ in. pipe. Larger size pipe, air ducts, tanks, etc., may be covered by splicing necessary widths together. For industrial use larger sizes and greater thicknesses of insulation material are available.

### Plug in Relays

**No. 3152—The hermetically sealed plug in relays developed by the Ward Leonard Electric Co., 37 South St., Mt. Vernon, N. Y., are designed for a-c or d-c operation control circuits and other applications where space is limited.**

Completely encased in a cylindrical can, these units are said to provide excellent protection against adverse atmospheric conditions such as moisture, dust, gases, corrosion, etc. Relay coil and contact connections are totally enclosed within the metal housing and are brought to the prongs of a standard octal plug base. They are available in contact combinations to double pole, double throw with a-c contact ratings (at commercial frequencies) of 4 amp from 0 to 115 volts and d-c contact ratings of 5 amp from 25 to 115 volts.

According to the manufacturer, these relays may be employed advantageously on electronic installations where quick relay replacement is necessary, where exposed wiring is hazardous, or where severe atmospheric conditions are encountered.

### Electric Meter Body for High Viscosity Fluids

**No. 3153—A new electric meter body with sealed armature, designed to insure better measurement of high viscosity fluids and gassing liquids, has been introduced by the Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., 4534 Wayne Ave., Philadelphia, Pa.**

The new meter body was developed to meet specific requirements of the chemical and petroleum industries, particularly for measuring flow of viscous liquids that are heated to permit pumping, or heated as a step in the process to which the liquids are subjected.

According to the manufacturer, satisfactory operation is obtained when measuring fluids that are highly viscous at normal temperatures. Meter response is improved and, when fluid is placed directly in the meter body, neither seal pots nor liquid purging is required. The meter is essentially self venting, high pressure connections being centrally located above the float chamber. The new armature assembly is sealed, protected and lubricated by a mercury fill, being repositioned by smaller variations in differential pressure.

The device can be used to measure hydrofluoric acid, mixtures of hydrofluoric acid and hydrocarbons, and volatile fluids with other characteristics. Suitable applications include tar and pitch, tower bottoms, bunker C fuel oil, volatiles such as butane and propane, steam, water, gases and hydrofluoric alkylation processes.

### Packing Rings

**No. 3154—"Palmetto Pyramid" packing, offered by Greene, Tweed & Co., 4377 Bronx Blvd., New York 66, N. Y., is available in molded ring form and has been designed to overcome the tendency of some V type packings to weaken and split at the hinge.**

The bottom ring is installed first and receives the full impact of the pressure on the power stroke. This bottom ring expands the wedge shaped lip of each ring above it so that the packing is pressed against both the rod and side walls. Binding is said to be prevented by the infiltration of fluid between the rings and by the storage of fluid in the arrowhead reservoir. On the return stroke the lessening of pressure is said to permit the restitutional property of each ring to exert itself, thereby enabling the rings to spring or contract to normal, thus preventing any braking action.

These rings may be used in any stuffing box, for rotary as well as reciprocal action. Sets can be supplied in styles and grades to withstand oil, water, and steam at any pressure and temperatures up to 600 F.

### New Plant Expansion Program

**No. 3155—The purchase of a new plant and plans for construction of additional manufacturing facilities have been announced by Minneapolis-Honeywell Regulator Co., 2604 4th Ave., S., Minneapolis 8, Minn.**

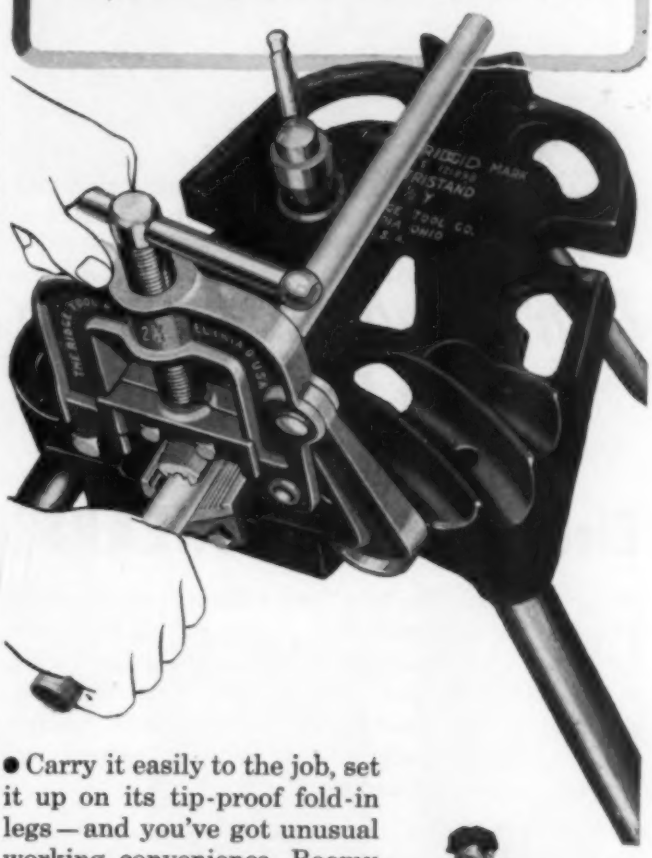
A two story building, adjacent to its main plant, containing approximately 22,000 sq ft of manufacturing space with footings for the addition of a third floor, together with land which will permit the future addition of a wing, have recently been acquired. In addition, work has started on the construction of a 34,000 sq ft, one story building which will be used primarily for expansion of machine shop operations. Under agreement with the CPA no critical materials are to be used in this building.

The foregoing program is in addition to the previously announced four million dollar expansion program. According to G. A. DuToit, Jr., vice president in charge of production, these recent moves were made on top of the company's general expansion program because of the current backlog of orders and because national surveys conducted by the company indicate a greatly enlarged market for heating, ventilating, air conditioning, and other controls.


RIDGID

TRISTAND

gives you a smart vise and handy work-bench all in one...

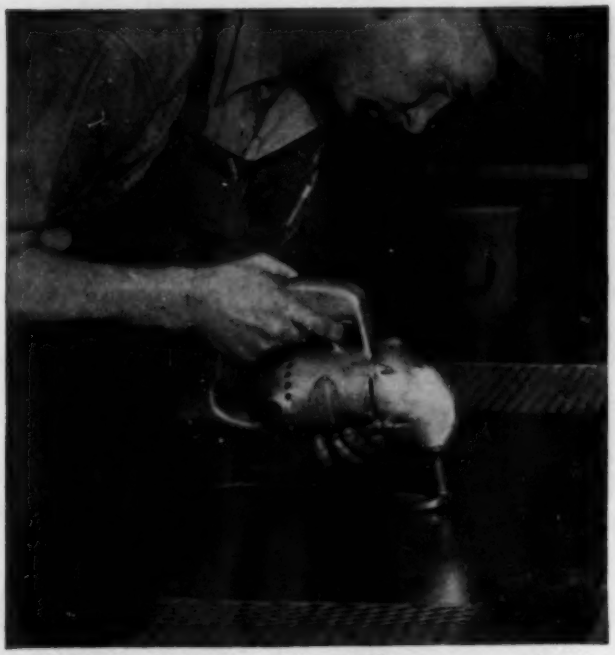


• Carry it easily to the job, set it up on its tip-proof fold-in legs—and you've got unusual working convenience. Roomy tray for dope pot, oil can, handy slots for tools, a pipe rest to make cutting or threading easier, 3 benders that won't dent pipe—and either yoke or chain vise with LonGrip jaws that hold pipe firmly without scratching. More for your money; ask your Supply House for RIDGID Tristands.

★ RIDGID ★

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.



30% SAVING IN COSTS and a 500% increase in production are reported by this user of 16-Gage Electric "Porto-Shears."

# *Don't Snip . . . Add Zip*

## to Sheet Metal Cutting with Black & Decker Electric "PORTO-SHEARS"

Black & Decker Electric "Porto-Shears" zip through jobs that are slow with snips . . . cut metals too tough for snips . . . make clean, smooth, accurate cuts with a big saving of time and trouble. Fast, powerful shearing action. Cutting operation always visible. Easy to follow straight lines, irregular patterns or curves down to 3/4" radius.

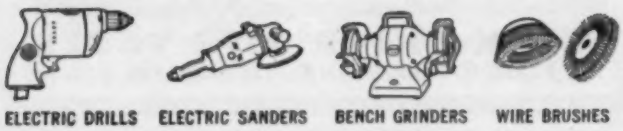
Two "Porto-Shears" models—16 and 18 gage—cut up to rated capacity in steel or galvanized iron . . . about one gage thinner in Monel or stainless . . . 50% above rating in copper, aluminum, lead and other non-ferrous metals. Operate on A. C. or D. C.

See your Black & Decker Distributor about "Porto-Shears" and other electric tools for sheet metal work, or write to: The Black & Decker Mfg. Co., 628 Pennsylvania Ave., Towson 4, Maryland.

LEADING DISTRIBUTORS EVERYWHERE SELL

**Black & Decker**

PORTABLE ELECTRIC TOOLS

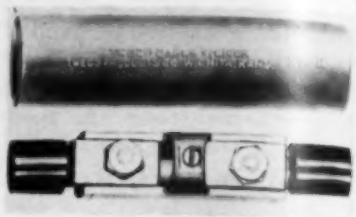


ELECTRIC DRILLS ELECTRIC SANDERS BENCH GRINDERS WIRE BRUSHES

### Welding Cable Splicer

**No. 3156**—A new line of welding cable splicers has been announced by the Tweco Products Co., Wichita 1, Kans. The new product is a companion to the quick, detachable connectors already offered by the company.**

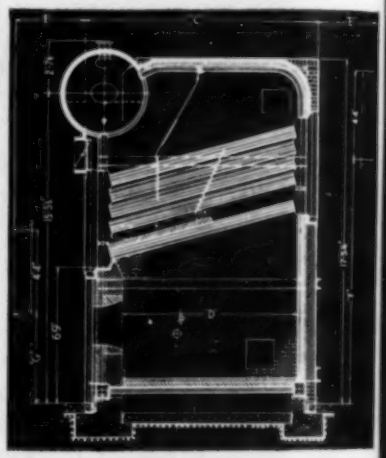
The units are designed to provide a quick repair of broken cables or salvaging short lengths. A simple clamp cable connection on each end of the splicer, with provision to solder between the cable ends, provides the connection. A fibre sleeve covers the splicer which is made in three sizes to cover the full range of welding cables.



### Water Tube Boilers

**No. 3157**—Development of a line of 12 standard water tube boilers, "M series," ranging in capacity from 6000 to 17,000 lb of steam per hr and designed for oil or gas firing, has been announced by Springfield Boiler Co., 1939 E. Capitol Ave., Springfield, Ill.**

The new boilers feature a water cooled furnace design and the standardization of dimensions for various size units. Two standard tube lengths, 10 ft and 12 ft, expanded into sinuous electric steel sectional headers, are used. All boilers in the line have 48 in. diameter welded, X-rayed, and stress relieved steam drums built to various pressure standards ranging from 160 to 320 psi. The overall setting height is 17 ft 5¼ in. for all units.



Erection at the user's location is facilitated by shop assembly of a considerable portion of the parts, including the header sections with built-in refractory filled cast iron baffles. Installation is further simplified by provision of structural steel framing to receive standard dimension refractory and insulating materials.

Features of the design, says the manufacturer, are simplicity of maintenance, minimum number of parts, and ability to operate considerably above rated capacity. Heat applied to steam delivery tubes and steam delivery above water level are features intended to insure dry steam and freedom from priming.

### Pressure Lubrication Pump

**No. 3158—The "1200 Series" direct drive gear pump has been designed by the McIntyre Co., 15 Riverdale Ave., Newton 58, Mass., for pressure lubrication of bearings of machine tools, engines, turbines, gener-**

ators, and **other high speed and heavy machinery.**

This small pump weighs only 8 oz and is said to operate with a volumetric efficiency of 95 per cent. Three standard models displace from 0.08 to 1.5 gpm at speeds ranging from 1140 to 3450 rpm against pressures up to 150 psi. Standard models are designed for direct motor application but units can be furnished for flange mounting, belt, spline, and other drives. Power requirements vary from 1/100 to 1/6 hp. The pump body is constructed of aluminum with nitrided alloy spur gears and shafts.

### Reproduces Climatic Conditions

**No. 3159—The "Aminco Climatizer" has been developed by the American Instrument Co., Silver Spring, Md., for producing, in laboratory test chambers and small size rooms, the average atmospheric conditions that prevail in most countries of the world.**

The unit is said to be of great utility in testing the performance, durability, etc., of devices and materials destined for use in almost any climate. It is also designed for use in assembling or packaging devices and materials that must be handled under precise atmospheric conditions. It may be obtained as an individual unit for application with a test chamber already in the customer's laboratory, or it can be supplied with a work chamber.

The use of highly sensitive controls is said to provide extreme sensitivity and immediate response to humidity changes.

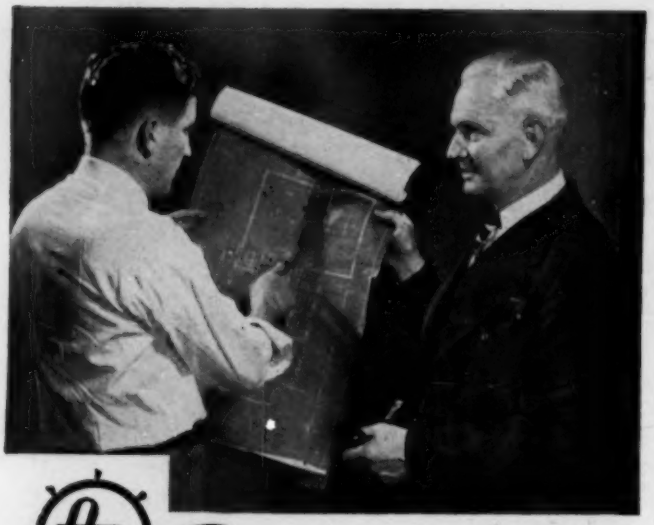
### Synchronous Motor Welder

**No. 3160—Now in production at the Hobart Bros. Co., Troy 1, Ohio, is a synchronous motor welder which utilizes an inbuilt separate exciter.**

The unit is designed so that it can be started across the line and will automatically synchronize itself by the buildup of the exciter. The starting current is said to be approximately the same as that of a conventional induction motor of the same capacity. The manufacturer recommends that the unit be operated to draw leading current at no load so as to compensate for other low power factor loads. Because of unity or leading power factor characteristics it is said to provide a power saving load.

This machine may also be used as an a-c generator for the operation of small tools, grinders, lathes, etc. This is accomplished by coupling the shaft to a gasoline or electric motor.

Warning!
SYNCROMATIC
is habit forming
as hundreds of dealers will testify and as shown by coast to coast acceptance of this line of TRULY modern steel warm air furnaces for . . .
COAL
GAS
OIL
Syncromatic Corporation
WATERTOWN, WISCONSIN

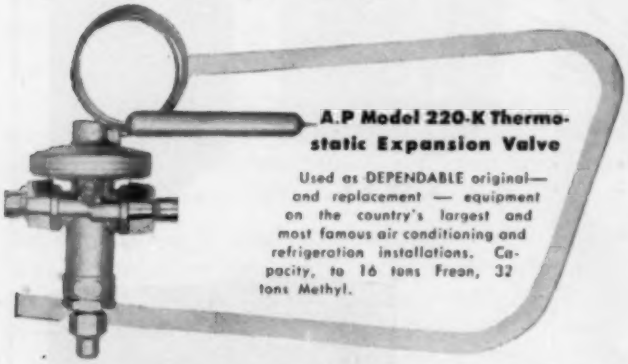


A-P Dependability

GOOD "PERFORMANCE INSURANCE" ON YOUR AIR CONDITIONING INSTALLATIONS

Experience may have shown you, too, that an A-P Thermostatic Expansion Valve on any air conditioning system is practical assurance of "trouble-free" refrigerant control so important to maintaining steady cooling efficiency. That's why A-P DEPENDABILITY, proven on thousands of installations, means so much to engineers responsible for these systems.

But A-P DEPENDABILITY is a proven fact long before you install the Valve on your unit . . . proven in amazing detail in every phase of production and operation. For instance, even before Expansion Valve diaphragms are made, a sample of the material is tested the equivalent of 15 years service in a valve. This is only one of the many "preproofs of A-P DEPENDABILITY" helping you to more efficient and trouble-free air conditioning.



A-P Model 220-K Thermostatic Expansion Valve

Used as DEPENDABLE original—and replacement — equipment on the country's largest and most famous air conditioning and refrigeration installations. Capacity, to 16 tons Freon, 32 tons Methyl.

AUTOMATIC PRODUCTS COMPANY

2460 North Thirty-Second Street, Milwaukee 10, Wisconsin

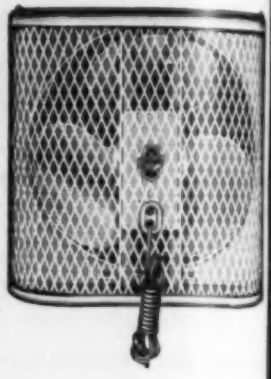
Export Dept. 13 E. 40th St., New York 16, N. Y.

DEPENDABLE Valves for Air Conditioning — Refrigeration — Heating

### Window Type Ventilating Fan

**No. 3161—A new 20 in. ventilating fan for window installation has been announced by The Emerson Electric Mfg. Co., 1847 Washington Ave., St. Louis 3, Mo.**

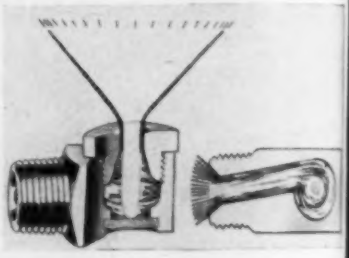
Designed to provide rapid air circulation in small homes, apartments, shops, stores, etc., the unit is rated at 3500 cfm free delivery. Installation is accomplished by placing two screw eyes in the window jamb, setting the fan on the window sill, and raising the window. The capacitor motor is plugged into a convenient outlet. Cabinet dimensions are 24 in. wide x 9 in. deep x 24 in. high.



### Tungsten Carbide Insert Used in Spray Nozzle

**No. 3162—A change designed to increase the service life of vortex type spray nozzles up to 100 times has been incorporated in the "Whirljet" spray nozzles made by Spraying Systems Co., 4031 W. Lake St., Chicago 24.**

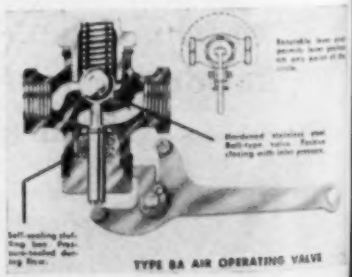
It consists of a tungsten carbide insert in the base of the vortex chamber, which resists the action of abrasive particles that may be mixed in the liquid to be sprayed. The whirling action set up in the vortex chamber of this type of nozzle has, in the past, made them subject to wear from abrasive particles. The use of the insert in the base is said effectively to reduce wear from this cause.



### Air Operating Valve

**No. 3163—A new self-sealing, air operating, ball type valve, known as type "BA," has been announced by Leslie Co., Valley Brook and Grant Aves., Lyndhurst, N. J.**

Fitted with a hand opening lever and a rotatable pivot so that the lever can be located in any position, this valve can be opened from almost any position with either a horizontal or vertical pull. The ball valve closes with inlet pressure and, according to the manufacturer, will not collect dirt or other foreign matter.



TYPE BA AIR OPERATING VALVE

The stuffing box is not accessible to tampering or

djustment and is self-packed by the operating pressure when the valve is open, permitting flow. Operating pressures up to 200 psi are recommended. It is constructed with a cast iron body, integral seating surfaces, screwed connections, and in ½ in. size.

### Vitreous Enameled Resistors

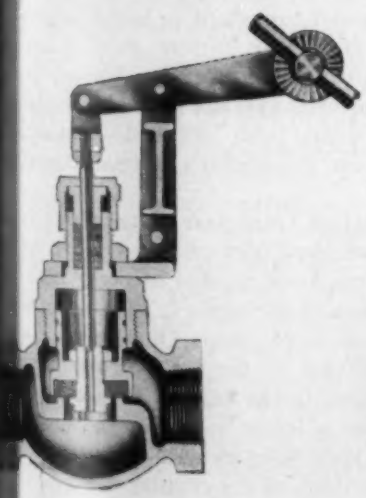
**No. 3164—Ward Leonard Electric Co., 37 South St., Mt. Vernon, N. Y., has announced the addition of "Vitrohm M" vitreous enameled resistors to its standard line.**

Meeting the requirements of U. S. Army-Navy specification JAN-R-26 for characteristic "F", these resistors are designed expressly for use on power type resistor applications where the severest operating conditions are encountered. These grade 1, class 1 resistors are available in ferrule, tab and screw terminal types with power ratings from 8 to 155 watts and capable of operation continuously at 275 C. Resistance values are obtainable in sizes covered by the specification, ranging from 0.1 to 80,000 ohms with resistance tolerances for one ohm and above of plus or minus 5 per cent specified values.

### Wind Induced Ventilators

**No. 3165—The C. R. Gelert Co., 35 N. Raymond Ave., Pasadena 1, Calif., has developed a new line of wind induced ventilators, under the trade name of "Airjet," designed for use on residences, industrial, and commercial buildings.**

These ventilators have a low silhouette which is said to adapt them to present day architecture and are light weight. Even the largest sizes need not be mounted over roof trusses, nor is additional flashing necessary—says the manufacturer. They have no moving parts and are said to be extremely efficient as certified by tests conducted in the Merrill wind tunnel of the California Institute of Technology. Among other advantages stressed by the manufacturer are elimination of down drafts and stagnant air, elimination of a transition piece and low cost. All units are machine made in volume and packaged knock-down to facilitate and economize storage and transportation. Vent flue caps are available in 4 in. and 6 in. diameter throat dimensions. Ventilators are furnished in six sizes with throat areas ranging from 12 in. x 12⅜ in. to 24 in. x 72¾ in. The monitor type is 24 in. wide and is available in any length desired.



# LOW FLOAT POWER
## required in K&M Float Valves

The new Kieley & Mueller Float Valve — piston balanced and pilot operated — is more responsive and more dependable in any service involving control of supply or drain in open or closed tanks, towers or reservoirs. Valve may be installed inside or outside of vessel, and submerged if desired. Shut-off is positive, operation is quiet, and minimum float power is required. Type 830 is all bronze, for pressures of 5 to 150 lbs., available in globe or angle patterns, with interchangeable discs for cold water or hot water to 350°. Sizes ½" to 2" with screwed ends. Type 834 valves are similar but are semi-steel, for pressures to 250 lbs., and have flanged ends in 2" to 12" sizes.

*Write for Catalog 66-C*

**KIELEY & MUELLER, INC.**
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS SINCE 1879
NORTH BERGEN, NEW JERSEY

WILLIAMS
SUPERIOR DROP-FORGED TOOLS
"VULCAN SUPERIOR"
CHAIN PIPE TONGS
7 sizes, with either Flat Link or Cable Chain, for pipe and fittings 1/8 to 12".

● **Pipe or fittings—it makes no difference to "Vulcan Superior," the universal service tong. You can switch from one to another without adjustment or change of parts. And "Vulcan Superior" is the only chain tong with *reversible* pipe-and-fittings jaws. When one set of teeth begins to wear, simply remove the Through-Bolt and reverse the jaws. Sold by Plumbing Supply and Industrial Distributors everywhere. Literature on request.**

**J. H. WILLIAMS & CO., BUFFALO 7, N. Y.**

# NEW BOOKS & REPORTS

## ASRE Proposes Standards for Rating and Testing Coolers

Proposed ASRE Standard Methods of Rating and Testing Water and Brine Coolers (ASRE circular No. 24-i) has been prepared by the Joint Committee on Rating Industrial Refrigerating Equipment. The committee, sponsored by the American Society of Refrigerating Engineers, undertook this work in order to provide a standard method of rating and testing these types of coolers under specific, standardized operating conditions, to permit both absolute and comparative evaluation of their capacity and performance, and to provide a measure of their performance characteristics under varying conditions of use.

To accomplish this objective, water and brine coolers are classified as to type, the terms used in rating this equipment are clearly defined, conditions and test methods for obtaining "ASRE Standard Ratings" are given and conditions of operation for "Application Ratings" are given. The types of water and brine coolers covered are closed shell and tube, closed shell and coil, open shell and tube, double tube, and open tank and coil.

The standard test methods require a primary test and a simultaneous confirming test which shall check within $\pm 3$ per cent. The primary test is used to find the refrigeration effect produced in the cooler by determining the heat removed from the water or brine together with the heat removed from the ambient air through the external surfaces of the cooler. In the confirming test the refrigeration effect is found by determining the product of the weight rate of refrigerant flow and the enthalpy difference of the entering and leaving refrigerant fluid.

Copies of this 5 page circular may be obtained from ASRE headquarters, 40 W. 40th St., New York 18, N. Y. The price is 25 cents.

## Variations from Normal Degree-Day Units

Average and Extreme Range in Degree-Day Units in the United States, by Stephen S. Visher, is a brief but informative paper published in the August 1945 Transactions of the American Geophysical Union, Vol 26, part 1. The information contained is based largely on data compiled by J. B. Kincer, former chief of the climate and crop weather division of the United States Weather Bureau, who used average degree-day units in ten sections of the country from 1898 to 1942 as a basis for comparison and for establishing normal annual degree-day units.

The range of variation from year to year was found to be least in the northeast part of the country, where the average departures from normal are only about 10 per cent, and the greatest variation is in the southeast where it is more than 25 per cent. Of note also is the lesser latitudinal contrast on the Pacific coast than on the Atlantic. According to the author, the Great Lakes apparently help cause a lesser range in the northeast than would occur if they were absent.

In the northern sections of the country from 50 to 6

per cent of the years are within 5 per cent of the normal degree-day units. In the central-southern section only one-third of the years is in this category, and in California and the south Atlantic states the figures are 26 and 17 per cent, respectively.

### ASRE Issues New Data Book

A completely revised and, in some cases, rewritten, 800-page, 2nd edition of the refrigerating data book, Refrigeration Applications, published by the American Society of Refrigerating Engineers, 40 W. 40th St., New York 18, N. Y., is now being distributed to its members, following which it will be made available to nonmembers.

This book covers almost the entire application field of refrigeration and air conditioning, and contains comprehensive and authoritative information adapted to the salesman or the design, installation, and service engineer.

Each of its 76 chapters is devoted to a specific application or closely allied subject and, beginning with the fundamental principles involved, describes the processes employed, with suggested values to be obtained. The text is interspersed with illustrations and tabulations.

The material has been divided into eight general classifications which include industrial and commercial applications of refrigeration and industrial and comfort air conditioning. The preparation of this data represents the combined efforts of a large number of engineers.

The book contains a classified section which lists refrigeration equipment products and the companies that manufacture them. This list has been subdivided and cross indexed for easy reference. Another feature is an extensive list of manufacturers of component parts and accessories of refrigeration systems, extending from automatic valves, bearings, and bushings to water valves, weatherstrips and welding electrodes.

### Recommended Practices for Resistance Welding

This is a compilation of recommended practices for the spot and seam welding of low carbon, stainless and hardenable steels, nickel, monel, and inconel; the projection welding of low carbon and stainless steels; flash butt welding low and medium forming strength steels; and standard methods for testing resistance welds. Each recommended practice comprises a table of machine settings for current, voltage, time, pressure, and other factors which will produce welds of specified strength in various thicknesses of materials. Explanatory text on each of the factors is included. The section on standard methods for testing resistance welds covers tests for tensile properties, shear strength, impact strength, fatigue properties and hardness. It includes a description of the test specimens, the equipment to be used, and the procedure to be followed. Also included is a section on control of weld quality by statistical methods. Copies of this 47 page booklet, Recommended Practices for Resistance Welding (Tentative), may be obtained from the American Welding Society, 33 West 39th St., New York 18, N. Y., at 50 cents each.


for • SPRAYING
• WASHING
• RINSING
• COOLING
• AIR CONDITIONING

YARWAY

SPRAY NOZZLES

FAN-TYPE FOR FLAT SLICING SPRAY

Get the most out of your Spraying Equipment with minimum power . . . with efficient spraying.

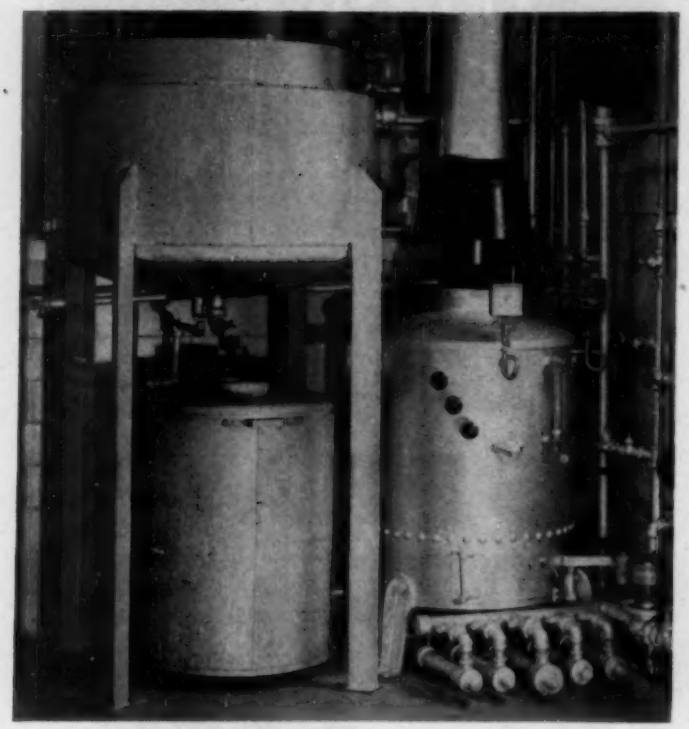
Use Yarway Nozzles. No internal vanes or other restrictions to clog or hinder flow. Two types—Yarway Involute-type producing a fine hollow spray with minimum energy loss, and Yarway Fan-type producing a flat fan-shaped spray with time-saving slicing action for cleaning.

Wide range of standard sizes and capacities. Cast of machined from solid bar stock.

Thousands in use. Write for new Bulletin N-617.

YARNALL-WARING COMPANY
107 Mermaid Avenue Philadelphia 18, Pa.

Heating Contractors:
How to
"Condense Costs"



Typical of how McKee fits the job is this Lard Kettle, with a 7 H.P. Type C Fast Steamboilerplant.

**Specify *McKee* GAS-FIRED "STEAMBOILERPLANTS",** to boil-down costs — on installations — on operation.

Easy and economical to install — just hook up to the gas, water and supply lines. A compact, clean-operating unit, it takes up little space for convenient location on the job. Remember, a McKee unit is complete; only one responsibility for satisfactory performance on the job.

McKee Eclipse

ECLIPSE FUEL ENGINEERING CO.

767 SO. MAIN STREET • ROCKFORD, ILLINOIS

Engineers in all principal cities

# MEETINGS & CONVENTIONS

*If you plan to attend a meeting soon, better check with the association concerned for any possible last-minute changes.*

### Construction Show to be Held in Los Angeles

Postwar developments in construction, home building, and related appliances will be exhibited at the first annual Construction Industries and Home Show of Southern California, July 12 to 21, at the Pan Pacific Auditorium, Los Angeles. Trade associations, contractors, and manufacturers will be among the many exhibitors. Management headquarters is at 3443 S. Hill St., Los Angeles 7, Calif.

### National Chemical Show and ACS Semi-Annual Meeting to Be Held Concurrently

The 4th National Chemical Exposition will be run concurrently with the semi-annual meeting of the American Chemical Society, to be held September 9 to 13. The show will again be sponsored by the Chicago section of the ACS and will be held at the Chicago Coliseum from September 10 to 14.

Marcus W. Hinson, who managed the three preceding exhibitions and will direct the 1946 renewal, states that over 80,000 sq ft of floor space will be available for displays and that over 200 exhibitors have already made reservations. He also stated that the show will cover the entire field of chemical products and chemical processes, with many exhibits reflecting the results of the war either in modifications resulting from changes in material resources or innovations brought about by war research and development work. Headquarters for the show is located in the administration building of the Coliseum at 1513 S. Wabash Ave., Chicago 5, Ill.

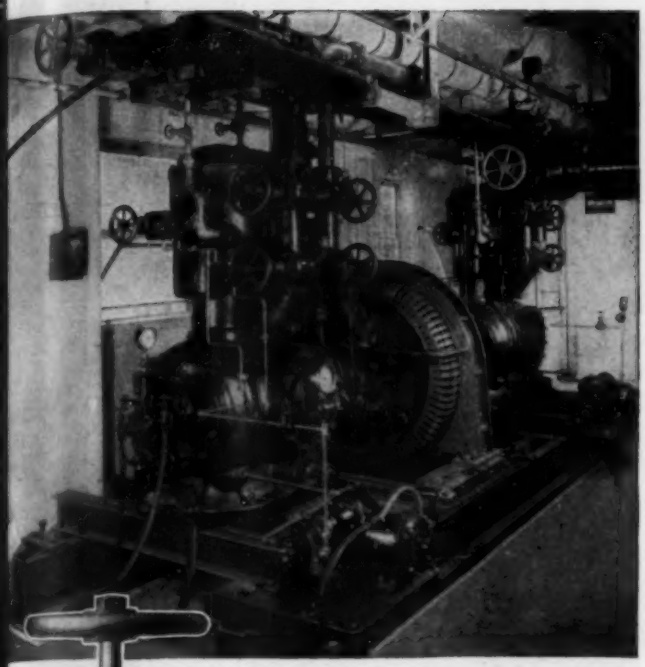
### ASME Meets in Boston and New York

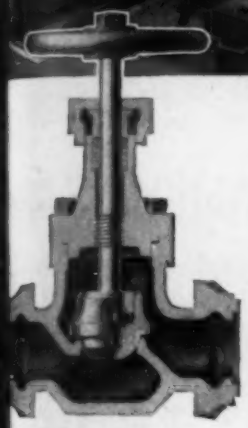
The fall meeting of the American Society of Mechanical Engineers, 29 W. 39th St., New York City, will be held in Boston, September 30 to October 2. The 1946 annual meeting has been scheduled for December 2 to 6 and will be held in New York City.

### Invitations Extended for All-Industry Refrigeration Show

K. B. Thorndike, chairman of the special committee arranging for the 4th All-Industry Refrigeration and Air Conditioning Exposition, has announced that more than 20,000 businessmen who are closely associated with the refrigeration, air conditioning, and the frozen food equipment industry will receive special invitations to the show to be held in the Cleveland Public Auditorium, October 29 to November 1. Invitations will also be extended to members of some 15 associations affiliated with the industry, and at least six of these associations will hold meetings in Cleveland at the time of the show.

The exposition, under the sponsorship of the Refrigeration Equipment Manufacturers' Association with the cooperation of the Frozen Food Locker Manufacturers and Suppliers Association, is expected to be the largest ever held by the industry.





*Section Thru Frick Globe Valve*

# Yes! Valves are Vitally Important

Good valves are to a refrigerating system what a good heart is to a man. They control the operation of the entire plant—must be safe, reliable, tight-closing.

You get these qualities and many more in Frick Valves. You get the patented high-angle seats, alloy-faced buttons, oversized stems, and back-seating features: you get the ability to stand hundreds of pounds of working pressure, and thousands of openings and closings, even when pulled-up with a wrench.

Frick valves and fittings are carried in stock by distributors in principal cities everywhere. Keep in touch with your nearest Frick man.

*Ask for Valves and Fittings Catalog K.*

**FRICK COMPANY**
**Waynesboro, Pennsylvania**

# All over America leading Insulation Contractors install NOVOID

Above are shown the employees of the Bonitz Insulation Company, Greensboro, N. C. And below is the architect's sketch of a standardized locker plant developed by Southern Frozen Food Lockers, Inc., for which Bonitz furnishes the Novoid Corkboard Insulation and Novoid Cork Pipe Coverings. More than 25 of these plants have been sold and will soon be operating in the Carolinas.

★ ★ ★

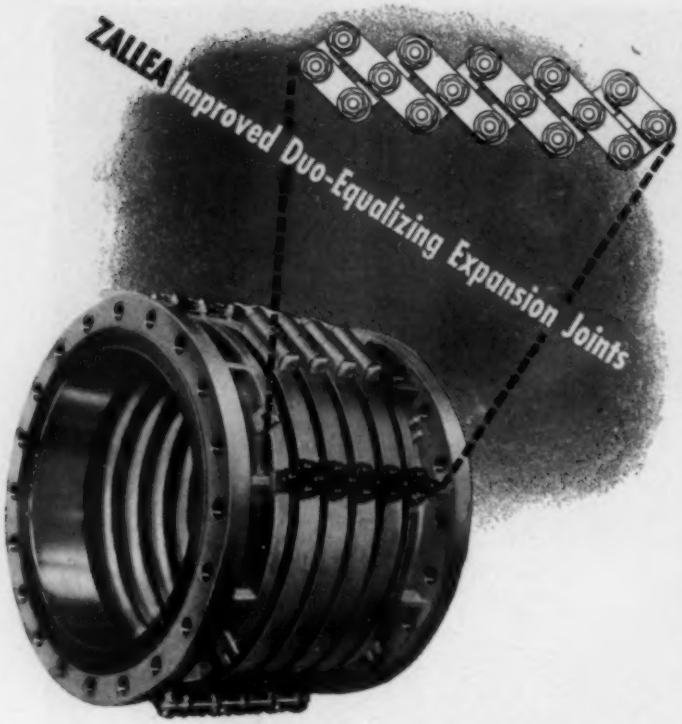
**NOW AVAILABLE** for prompt delivery are many sizes and thicknesses of Novoid Cork Pipe Covering. From coast to coast, better independent insulation contractors can sell you this highly efficient insulation for cold lines.

Novoid Covering is the moulded rigid insulation that reduces your cost of refrigeration. It snugly hugs pipes and fittings of every size and shape, does not sag, does not absorb moisture or odors, and is long-lasting.

For complete facts about Novoid Pipe Covering, Corkboard, and sundries especially developed to make low temperature insulations most efficient, write to Cork Import Corporation, 330 West 42nd Street, New York City.

# NOVOID INSULATION

**CORKBOARD • PIPE COVERING**




**. . . pantograph linkage divides every movement equally**

In the new Zallea Improved Duo-equalizing* Packless Expansion Joint equal and simultaneous absorption of line movement among all corrugations is made positive by the unique pantograph chain linkage. Under contraction as well as expansion—whether the joint is absorbing its full rated traverse or only a portion of it—every movement must be divided equally.

That is why Zallea Improved Duo-equalizing Expansion Joints have longer life—why they endure in the severest service.

*U. S. Pat. Pending

*Made of copper, stainless steels and other corrosion-resistant alloys . . . Diameters from 3" upward . . . Traverses up to 7½" per single unit . . . For pressures from vacuum to 300 psi . . . For temperatures from sub-zero to 1600°F . . . Let us quote on your requirements.*

"Code-Craft"...
**ZALLEA BROTHERS & JOHNSON**
EQUIPMENT FOR THE PROCESS INDUSTRIES
816 LOCUST ST. • WILMINGTON 99, DEL.

**SPECIFY and DEMAND ZALLEA**
***Furnace-Annealed* EXPANSION JOINTS**

Exposition headquarters is 1107 Clark Bldg., Pittsburgh 22, Pa., also headquarters of REMA.

### AWS Annual Meeting to Be Held With National Metal Congress and Exposition

The 1946 annual meeting of the American Welding Society, which will open in New York on October 21 and be adjourned immediately, will be reassembled in Atlantic City, November 17-22, for the meeting to be held in conjunction with the National Metal Congress and Exposition.

The exposition will be held in the Atlantic City Convention Hall, and technical sessions, committee meetings, and social functions of the AWS will be held at the Ambassador hotel. Further information may be obtained from the American Welding Society, 33 W. 39th St., New York City.

### International Heating and Ventilating Exposition Expected to Be Sellout

Over 200 leading manufacturers have already engaged exhibit space for the 7th International Heating and Ventilating Exposition, scheduled for Lakeside Hall, Cleveland, Ohio, January 27 to 31, 1947. It will be held under the auspices of the American Society of Heating and Ventilating Engineers, and in conjunction with its 54th annual meeting.

Approximately 75 per cent of the total exhibit area has been reserved, but there are still a limited number of choice locations available.

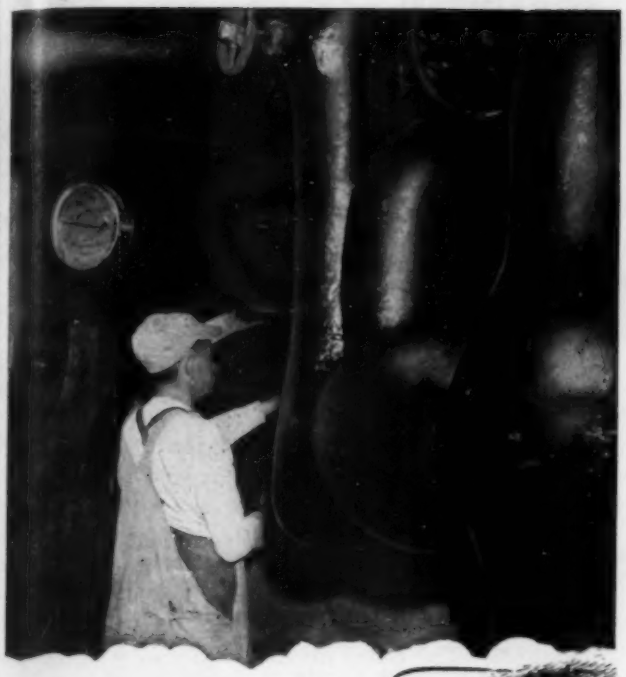
The exposition is under the management of International Exposition Co. with permanent headquarters at Grand Central Palace, New York, to which communications should be sent.

---

### Champion Weight Guesser

As a fan balancer for Carrier Corp., Syracuse, N. Y., Esther Bordynski has checked high speed fans for three years at a rate of 120 daily. She spots underweight blades by eye and puts them in balance by adding a dab of solder. Her fellow workers say she

has never missed guessing the proper weight by more than 5 grains (1/1400 lb.). We wonder if she can guess that close when buying butter—well, it was just a thought.



For Insulation Jobs, too-

# IT HAS TO BE RIGHT THE FIRST TIME

**When it comes to insulations, *"nearly right" is wrong!***

That's why it pays to get J-M Rock Cork . . . standard of the refrigeration industry for years!

Basically mineral in composition, Rock Cork has low thermal conductivity, plus high resistance to moisture, vermin and rot.

Remembering that insulation will only render its maximum efficiency when properly applied, Johns-Manville also offers an application service of skilled construction units. These units are organized to handle every detail of your insulation requirements from plans to finished job.

For details about Rock Cork, write for brochure DS-555, or get in touch with your J-M Insulation applicator. Johns-Manville, Box 290, New York 16, N. Y.

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**Johns-Manville**

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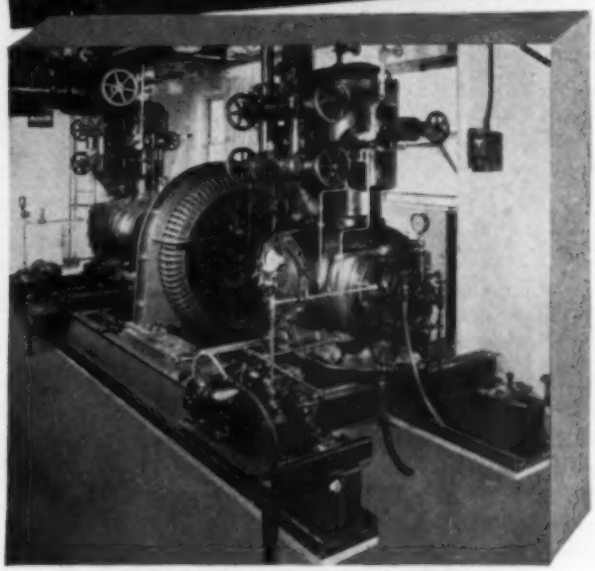
# KORFUND VIBRATION CONTROL FOR *Compressors* And All Other Air Conditioning Equipment



Korfund Vibration Controlled installation on the fourth floor of a large department store.

**Air conditioning equipment is installed to provide comfortable working and living conditions. In consequence, Vibration Control is a "MUST," where machinery noise and vibration are most irritating and undesirable. Korfund Vibration Control units reduce noise and vibration transmission so effectively that persons in the building cannot tell when the equipment is operating.**

**On *all* air conditioning installations, Korfund does a two-fold job. First, it eliminates the disturbing operating noise. And second, Korfund prevents vibration transmission that can be both annoying and dangerous to the building structure.**

**The Korfund Co., Inc., is now sole distributor of Armstrong Standard Density Vibracork. Write for details.**

**Korfund offers you Engineering Service with over forty years' experience in Control of Vibration. Write today about your vibration problems.**

**KORFUND**

**VIBRATION CONTROL**

THE KORFUND COMPANY, Inc., 48-38 32nd Pl., LONG ISLAND CITY 1, NEW YORK

# RECENT TRADE LITERATURE

*For your convenience in obtaining copies of these bulletins, see coupon on page 149. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.*

### Axial Flow Pumps

No. 6181—Large volume, axial flow pumps are covered in a 16 page catalog (No. G845) issued by Economy Pumps, Inc., 1000 Weller Ave., Hamilton, Ohio. According to the manufacturer, recent developments have improved the efficiencies and extended the range of these pumps which are now available in capacities from 500 to 100,000 gpm at total heads up to 50 ft. The units, designed for use where large volumes of water are required at moderate heads, are being used, not only for municipalities, but also for large buildings, and industrial plants.

### Circulating Fans for Refrigerated Spaces

No. 6182 — Recommended installation methods together with a discussion of the advantages in using refrigerator fans are featured in an 8 page bulletin (No. 241) issued by the Reynolds Electric Co., 2603 W. Congress St., Chicago 12, Ill. "Reco" refrigerator fans are also described and illustrated.

### Cleaning Methods In Industry

No. 6183—How to Speed and Simplify Cleaning Methods in Industrial Plants is the subject of a bulletin (No. AS-362) issued by Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Calif. Information concerning rust removal, water scale elimination, steam cleaning, paint stripping, metal surface treatment, and general maintenance is given. Copies printed in Spanish are also available.

### Combined Rivet and Nut Plate

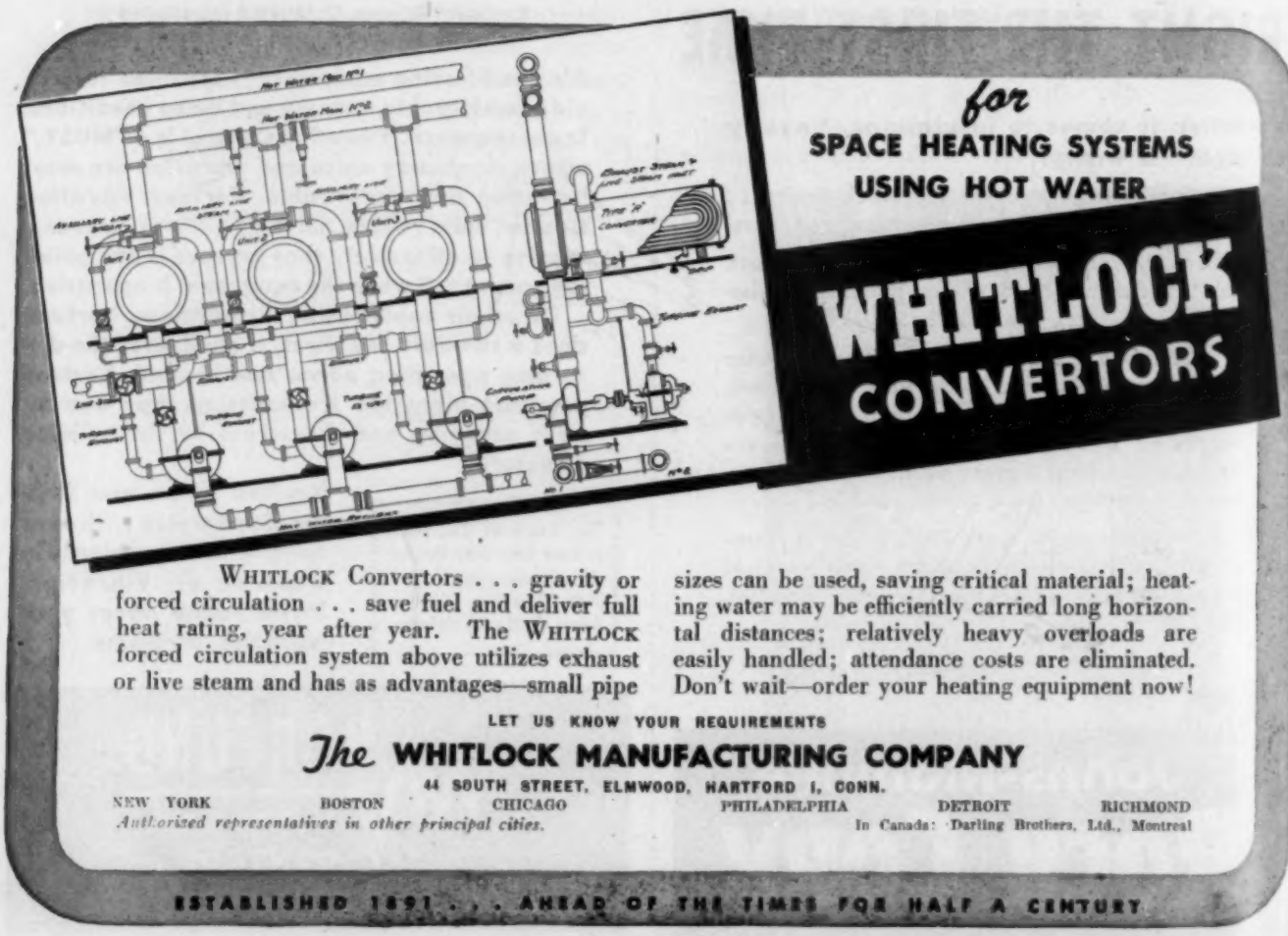
No. 6184—Another in the series of booklets on the subject of the "Rivnut," a one piece blind rivet and blind nut combination, has been published by the B. F. Goodrich Co., 548 S. Main St., Akron 18, Ohio. It is titled I'm always Getting Into Other Peoples Business and describes some of the postwar uses which have been found for this product which was originally developed as a fastener of the company's de-icer to metal planes.

### Commercial and Industrial Stoker

No. 6185—The Sun-Fire Stoker Corp., New Albany, Ind., has issued a 4 page bulletin illustrating and describing the company's line of commercial and industrial stokers which are available for boilers from 30 to 310 hp.

### Condenser Tube Inserts

No. 6186—"Flowrites," metal inserts for inlet ends of condenser tubes, which are designed to prevent tube


WHITLOCK Convertors . . . gravity or forced circulation . . . save fuel and deliver full heat rating, year after year. The WHITLOCK forced circulation system above utilizes exhaust or live steam and has as advantages—small pipe sizes can be used, saving critical material; heating water may be efficiently carried long horizontal distances; relatively heavy overloads are easily handled; attendance costs are eliminated. Don't wait—order your heating equipment now!

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### REDUCING VALVE

**Designed for Low Pressure Steam Systems with initial pressures up to 85 lbs.**

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**Special Rubber Diaphragm provides extremely accurate regulation.**

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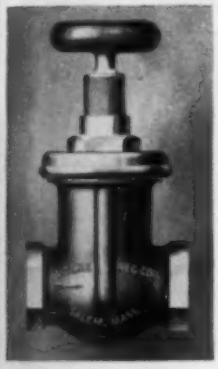
**Variable Low Pressure Range controlled by adjusting screw.**

●

**In-Built Quality and Rugged Construction — a regular Locke feature.**



## LOCKE No. 24
### PILOT-OPERATED REDUCING VALVE

**Reduces and Maintains Uniform Steam, Oil or Air Pressure, regardless of variations in initial pressure or volume required**

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**Action of Main Valve controlled by small Auxiliary Valve.**

●

**Bronze Body supplied in valves up to 2". Iron body and bronze interior on valves 2½" or above.**

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DIVISION OF THE H. T WILSON MACHINE CO., INC

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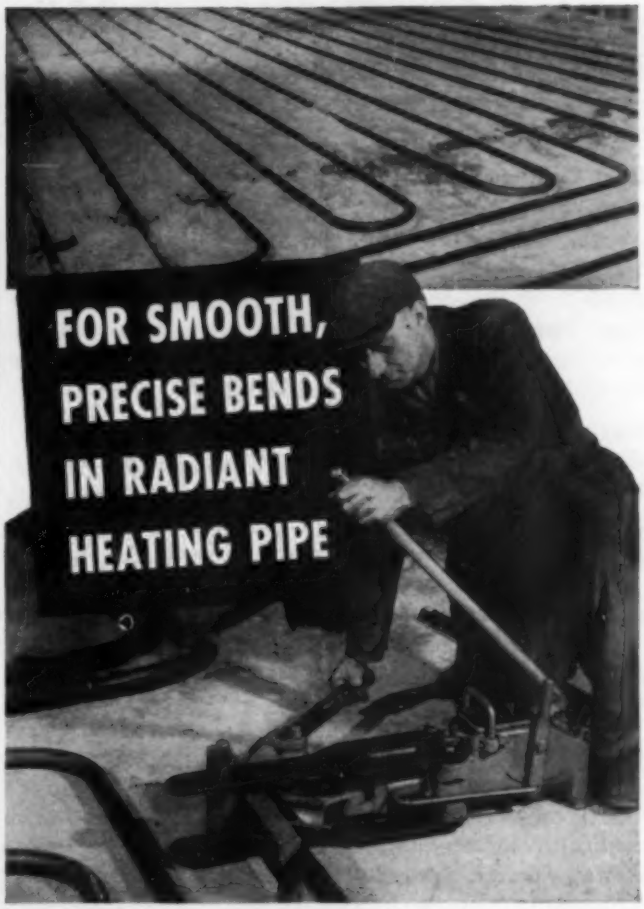



● Install radiant heating pipe the swift, sure way...with the GREENLEE 770-R Hydraulic Pipe Bender which makes precise 90° and return bends in *cold* pipe of sizes ½" through 2".

After making the above illustrated radiant installation with the aid of a GREENLEE, Bilz Plumbing and Heating Co., Spring Lake, Michigan, reported as follows. "One man operates the GREENLEE Bender easily *and fast*, thus providing a tremendous saving in labor hours."

"There's no flattening of pipe with a GREENLEE Bender, it brings substantial savings in fittings and manufactured bends. And, most important, there is *much less friction loss* in the system with curve bends instead of regular square fittings."

Do the job easier, faster, *better* with a GREENLEE. One-man-operated, compact, portable for on-the-job work. Two models for pipe from ½" to 4½". Write for details. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2346 Twelfth Street, Rockford, Illinois.

REGISTERED TOOLS
**GREENLEE**
FOR THE CRAFTSMAN

end erosion, are described and illustrated in an 8 page pamphlet issued by Condenser Service & Engineering Co., Inc., 95 River St., Hoboken, N. J. Reports of tests conducted at the Massachusetts Institute of Technology and installation instructions are included.

### Dust Collector

No. 6187—A small, 500 cfm, dust collector unit which consists of two cyclone type collectors, a fan, and a filter and which is designed for use with various machine tools, is described in a 4 page folder published by Ideal Industries, Inc., 1294 Park Ave., Sycamore, Ill. Also mentioned are a number of machine shop accessories which are offered by the company.

### Electronic Potentiometer-Pyrometer

No. 6188—A 16 page bulletin (No. 232), issued by Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio, describes and illustrates a new electronic potentiometer-pyrometer which records one or two temperatures on a 12 in. diameter chart and indicates on a 29 in. bold scale which encircles the recording chart. Various indicating, recording, and controlling combinations are covered and principles of operation and performance data are included.

Conventional thermocouples are used for temperatures up to 3000 F and for temperatures above 300 F and for moving objects above 1500 F, radiation type thermocouples are used. Instead of a galvanometer or millivoltmeter the unit employs a d-c to a-c converter and an electronic detector to measure potentiometer unbalance.

### Graphical Method for Design of Radiant Panel Heating Systems

No. 6189—In the design of radiant panel heating systems, the basic questions which must be answered deal with required panel area, the size and spacing of pipe coils, required water temperature, boiler size, and the rate of water circulation through the coils. In an effort to provide a rapid and simplified method for determining these factors, Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N.Y., has published a 56 page, 8 x 11½ in., booklet, A Graphical Design Procedure for Radiant Panel Heating.

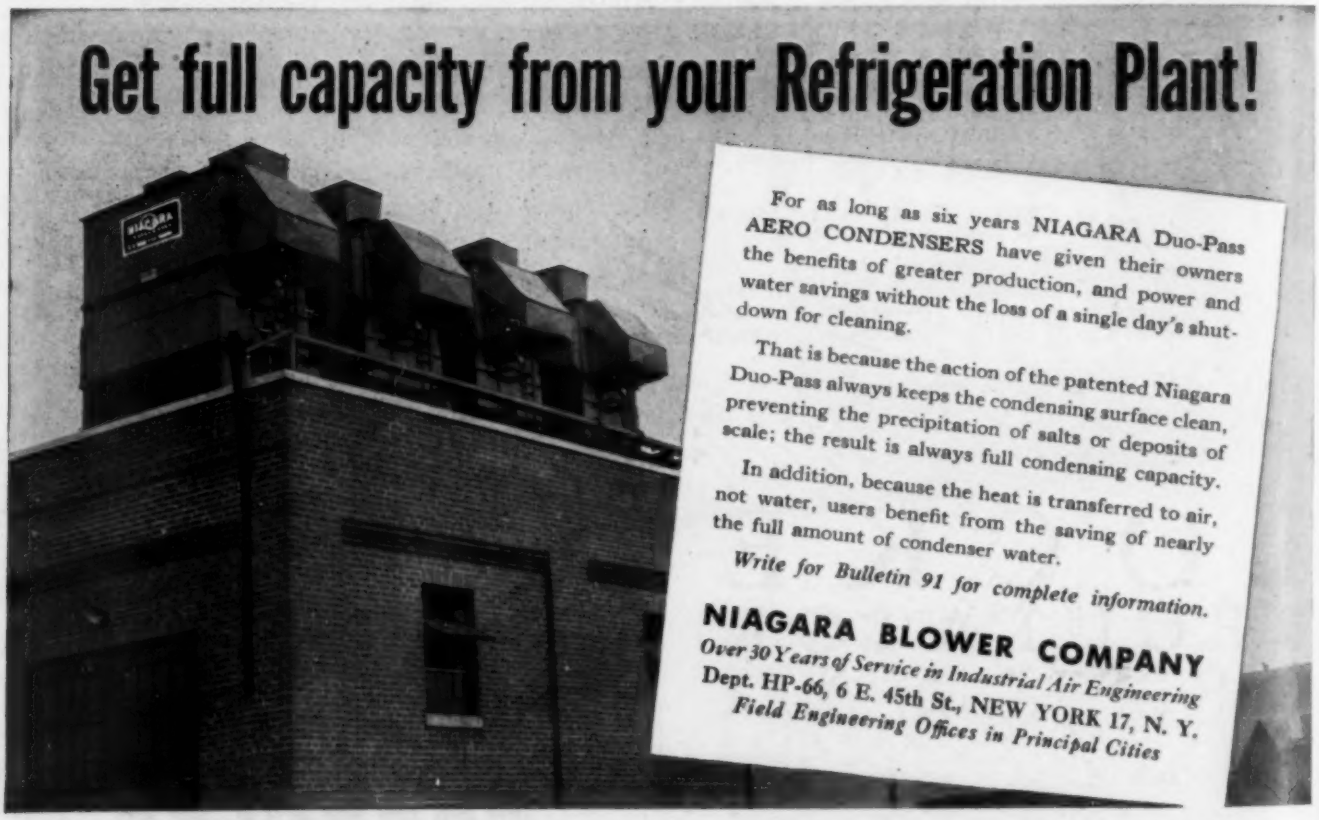
Preparation of the material contained in this manual was carried on under the direction of Prof. F. W. Hutchinson, Purdue University. His graphical method is based on the rational heat balance procedure developed in a series of technical papers of which he is the author or co-author. A number of his papers have been published in previous issues of HPAC.*

The only calculation of any length involved in this method is in the determination of the equivalent overall room coefficient $U_e$ (in accordance with the method given in the ASHVE Guide). Using design outside air temperature and an assumed maximum panel surface temperature, the ventilation rate in terms of air

*Panel Heating and Cooling Analysis, B. F. Raber and F. W. Hutchinson, ASHVE Journal Section, Heating, Piping & Air Conditioning, Vol. 13, No. 8, (August 1941), pp 512-523.

Simplifying the Calculations for the Exchange of Radiant Heat, B. F. Raber and F. W. Hutchinson, Heating, Piping & Air Conditioning, Vol. 16, No. 9, (September 1944) pp 530-532.

A Single-Equation Design Procedure for Radiant Panel Systems, F. W. Hutchinson, ASHVE Journal Section, Heating, Piping & Air Conditioning, Vol. 17, No. 12, (December 1945), pp 637-642.



Get full capacity from your Refrigeration Plant!
For as long as six years NIAGARA Duo-Pass AERO CONDENSERS have given their owners the benefits of greater production, and power and water savings without the loss of a single day's shut-down for cleaning.
That is because the action of the patented Niagara Duo-Pass always keeps the condensing surface clean, preventing the precipitation of salts or deposits of scale; the result is always full condensing capacity.
In addition, because the heat is transferred to air, not water, users benefit from the saving of nearly the full amount of condenser water.
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NIAGARA "NO-FROST" COOLING SYSTEMS
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**TIME-TESTED**
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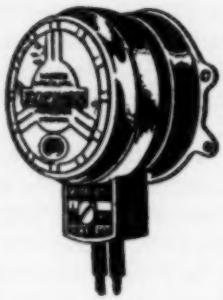
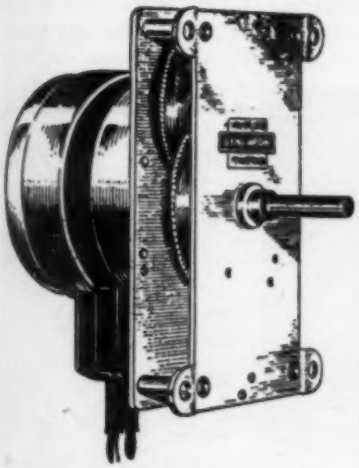
**MINIATURE—**



# SYNCHRON
## TIMING MOTORS
## AND
## TIME MACHINES



● Finally released from "command" Government contracts, our entire organization is again geared to produce SYNCHRON timing motors and time machines in quantities which will soon equal the pent-up demand. Orders will be filled in the order accepted. Our engineers will collaborate on special designs.

● SYNCHRON Motors are compactly built, with rotor and coil nested in a sturdy, streamlined case only 2¾" x 15/16". These motors have power to pull 8 oz. direct load continuously at 1 RPM, and they are pre-tested to operate at 30 degrees below zero or 140 above.

● SYNCHRON Timing Machines—powered by SYNCHRON Motors—are accurate, long-wearing, and easy to mount. They operate at standard intervals of 1 RPM, 1 RPH, 1 RP12H, and 1 RPD.

*Write for SYNCHRON Catalog, complete with engineering data.*

**HANSEN MANUFACTURING, Inc.**
**Princeton 6, Indiana**



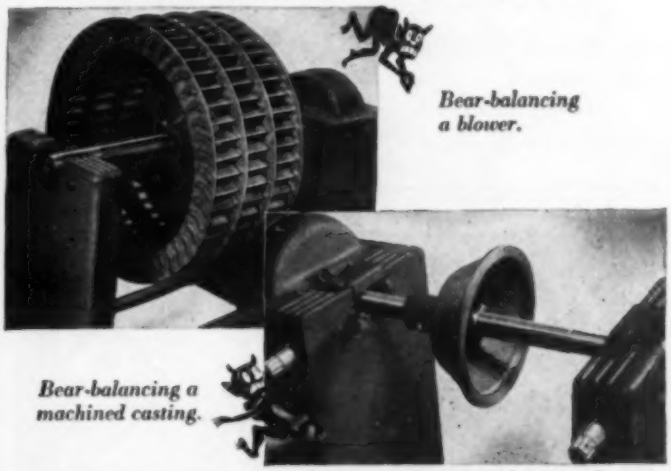
# MACHINING *ALONE* CAN'T CORRECT DY-NAMIC UN-BALANCE

*Save shop time, add years to product life, with a low-cost, quick-acting Bear Dy-Namic Balancer!*

**Get *FREE* Catalog!**

Every day, production-sampling tests prove definitely that workmanship, however fine, simply cannot insure dy-namic balance in rotating parts. And since destructive unbalance increases enormously as RPM steps up . . . and since the resulting "wobblies" are discovered by the user and not in your shop . . . it stands to reason that scientifically accurate dy-namic balancing is essential if your products are to serve better and sell easier.

## NOW DY-NAMIC BALANCING IS QUICK, EASY, LOW-in-COST!



*Bear-balancing a blower.*

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No longer does dy-namic balancing cost too much in time, equipment and operator-education. Bear has ended that! Now, with a low-priced Bear Dy-Namic Balancer the job can be done as a part of routine production. In a matter of seconds, a job of balancing can be done that will meet any standard requirement. So easy to operate that any shop hand can learn to Bear Balance in a few hours!

## GET INFORMATIVE *FREE* CATALOG

See how quickly and easily, and at what low cost, you can give your products the operating and sales advantage of Bear Dy-Namic balancing! The Bear line embraces models for balancing bodies from a few ounces to tons . . . yours is here! Write for the Bear catalog! BEAR MFG. CO., Industrial Div., Dept., HPAC, Rock Island, Illinois.

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**COMBINATION**
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**ATTACH TO LETTERHEAD—MAIL!**

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**Gentlemen: At no cost or obligation to me, please send me your catalog.**

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## How much fuel, energy and equipment could you save by saving conditioned air?

Converting 1000 CFM of stale, odorous air to fresh air with Dorex *activated carbon* Air Recovery Equipment, instead of bringing in and conditioning outdoor air, saves:

100,000 BTU of installed heating capacity
3 tons of installed refrigeration
1800 KW hours of current per cooling season
1500 gallons of fuel oil or
9 tons of coal per heating season
Incidental water consumption and maintenance

} Per 1000 CFM of heated or cooled air saved

The above savings are figured for average temperate zones. Some installations have shown greater savings, some less. But in every case, Dorex Air Recovery has *converted contaminated air to fresh air* at a cost much below that required to replace it with an equal volume of outdoor air.

We will be glad to give you the details on actual savings in typical installations or estimate the savings on any existing or planned system. For full information call the nearest District Representative or write Dept. D-11.

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**Do You Know...**

5" 5"to 12" 12"

Janette Builds 63 different sizes of single inlet and 22 sizes of double inlet wheels, with air capacities of from 67 to 4620 c.f.m. . . . A special patented construction is used which results in an exceptionally rugged wheel that will last indefinitely.

**For Over 20 Years Janette Blower Wheels have given complete satisfaction** to internationally known manufacturers of air conditioning, ventilating and drying apparatus, superchargers, dust collectors, coal stokers, oil burners, air cooled engines and fire detection equipment. **For Smooth, Quiet, Dependable Performance SPECIFY JANETTE BLOWER WHEELS**

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Janette

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556 W Monroe St Chicago 6, Ill

No Other Wheel Like It

Patented Construction

Built For Hard Service


changes per hour, untempered air is determined. A geometry correction factor, dependent on the room dimensions, and a ventilation correction factor are then determined from the charts. Panel design charts are used to find the per cent of room surface to be heated, the panel rating in Btu (hr) (sq ft), and the design value of the comfort air temperature. A number of tables for selecting copper tube sizes and spacings for use in panel coils is provided. The data in these tables are based on laboratory tests sponsored by the manufacturer and are for plaster panels in which the copper tube is located ¼ in. from the face of the panel which is insulated so as to reduce to a negligible quantity the heat transfer from any surface except the panel face. For concrete panels with copper tubes embedded (¼ in. from tube wall to panel face) it is recommended that the temperature difference between the water and the panel face be taken as 25 per cent less than the values tabulated for plaster panels of the same rating.

A flow rate chart is included which may be used to find the rate of flow in gpm through the panel for a selected temperature drop, or conversely, for determining the temperature drop for a predetermined rate of flow. In using this graphical procedure, the mean radiant temperature does not have to be determined, but it may be found by using a simplified equation given in the manual.

### Heating With Superheated Water

No. 6190—The "Supertherm" system of process heating, which uses superheated water, is described in a 10

GOT A WATER SCALE PROBLEM?

*Solve it with . . .*

SOL-VET "08"

• **SOL-VET "08"** is a fast, efficient cleaner of all equipment using water for cooling. By dissolving impurities *completely* they are carried out *in solution*, and clogging is eliminated. Head pressures fall to normal; heat transfer is raised to maximum; full circulation is restored; life of equipment prolonged. On large jobs, shutdown time is cut to a maximum of 6 to 8 hours.

**GUARANTEED EFFECTIVE** If you find SOL-VET "08" is not exactly as represented, when used according to instructions and full, accurate report is given within 30 days from date of purchase, your money will be *refunded in full.*

**GUARANTEED HARMLESS** when used as directed, to all water conducting materials used in water cooled equipment.

**WRITE TODAY** for complete data and analysis and recommendations for your specific problems.

ANDERSON - STOLZ CORPORATION
1731-33 WALNUT ST. KANSAS CITY 8, MO.

page booklet published by the Power Piping Div., Blaw-Knox Co., 829 Beaver Ave., Pittsburgh 12, Pa. The system, which consists of drawing water at steam saturation temperature from any standard industrial boiler and circulating through a completely closed pipe system by means of a specially designed pump, is said to lend itself particularly to the manufacture of molded plastics, rubber, textiles, ceramics, floor coverings, wall paper, and chemicals.

### Photoelectric Colorimeter

No. 6191—The "Lumitron" colorimeter, model 450, a photoelectric instrument for measuring the light transmission of liquids in Nessler tubes, is described and illustrated in a 15 page booklet published by the Photovolt Corp., 95 Madison Ave., New York 16, N.Y. The instrument is designed particularly for the measurement of faint colorations and turbidities and is said to be especially suitable for the trace analysis of water, metals, and soil extracts. It is also used for color grading of lightly colored liquid products.

### Pipeline Cleaner

No. 6192—A pipeline cleaner designated as an "all purpose flushing gun," which is designed to utilize water impact to clear piping systems, is described in a 2 page folder issued by the Miller Sewer Rod Co., 4638 N. Central Ave., Chicago 30, Ill.

### Plastics

No. 6193—The annual plastics brochure published by General Electric Co., Plastics Div., 1 Plastics Ave.,

"American"

COLD PIPE, CONDUIT and TUBE BENDING MACHINES

*Twelve types to select from.* Hand operated capacities ⅛ to 6" inclusive. Motor operated ¾ to 8" inclusive.

*A few of our More Than 12,000 Customers:*

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*Write Air Mail for printed matter.*

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*Quick Deliveries*

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AUTO-VENT AIR ELIMINATORS

Venting Hot Water Unit Heater

***Circulation Troubles?***

Don't fight air pockets or traps in hot or cold circulating lines! "Get that air out of there" *and keep it out* simply by installing the No. 7 Maid-O'-Mist Automatic Air Vent. This reliable air vent has a self-closing float-controlled valve and is designed especially for circulating pipe lines, concealed radiators, unit heaters, cooling manifolds, tanks, diesel engines, or any other application where air pockets or traps retard the free circulation of liquids. Now available in bright brass finish. For pressures up to 75 pounds.

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AUTOMATIC HUMIDIFIERS OF ALL TYPES FOR HEATING SYSTEMS

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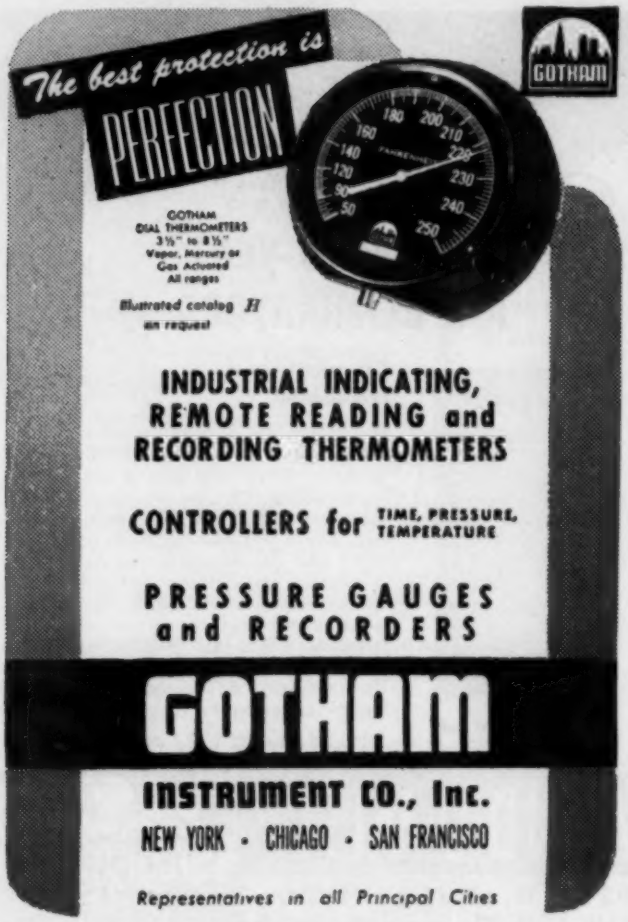



Pittsfield Mass., has recently been issued. The company's facilities for research, development, design, moldmaking, manufacturing, and molding are described and illustrated.

### Propeller Fans

No. 6194—A 28 page catalog (Unit No. X5549) recently issued by The Emerson Electric Mfg. Co., 1847 Washington Ave., St. Louis 3, Mo., gives design and construction specifications with performance data on various types of desk fans, air circulators, ceiling fans, exhaust, and cooler fans. Several new products including a 20 in. window type cooler fan are included.

### Pyrometer Controller

No. 6195—A 4 page bulletin (No. D4-2) issued by Wheelco Instruments Co., Harrison and Peoria Sts., Chicago 7, Ill., describes the company's "Multronic Capacitrol," a multi-position, electronic, pyrometer controller. Various applications are listed and a description of the operation, together with typical installation diagrams, are included.

### Quick Couplings

No. 6196—Hardened steel balls retained in a ball cage provide the means of effecting a lock in the line of quick couplings offered by Roylyn, Inc., 8929 Santa Monica Blvd., Los Angeles 46, Calif. These couplings, available in aluminum alloy, corrosion resistant steel, commercial brass, and alloy steel, are described and illustrated in a new 10 page booklet which includes dimensions and allowable working pressures.

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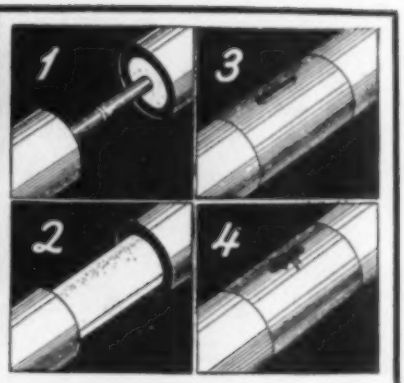


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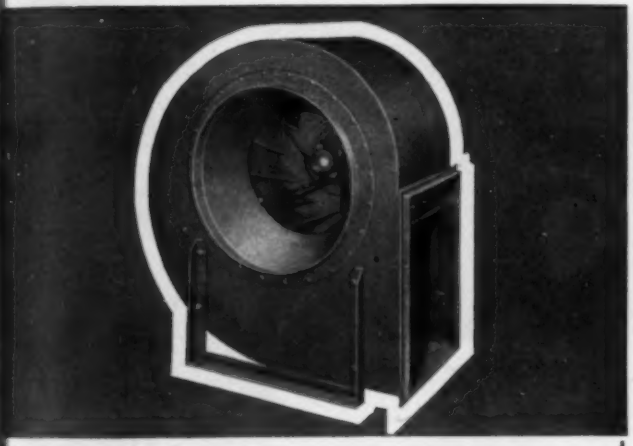

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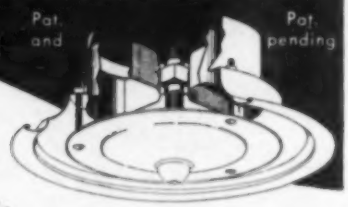


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### Refractory Combustion Chambers

No. 6197—B. A. Peterson Co., Dowagiac, Mich., has issued a folder describing "Petco" interlocking combustion chambers. Made in both rectangular and round types, these refractory chambers are designed for use with oil burners up to 3 gph fuel consumption and for installation in many types of furnaces and boilers.

### Refrigeration Valves

No. 6198—A 10 page catalog, issued by Automatic Products Co., 2460 N. 32nd St., Milwaukee 10, Wis., covers the company's line of refrigeration expansion valves, suction pressure regulating valves, solenoid valves, dryers, and strainers. Water regulating valves and solenoid water valves are also described. Dimensions, capacities, and list prices are included.

### Resistors and Rheostats for Electronic Industries

No. 6199—Catalog No. D-2 is the first to be compiled expressly for the electronic industries by the Ward Leonard Electric Co., 37 South St., Mt. Vernon, N.Y. It gives data on "Vitrohm" wire wound, vitreous enameled resistors and on rheostats which are designed for use with electronic instruments.

### Sheet Felt

No. 6200—Some of the many commercial and industrial uses of sheet felt (carded wool which has been worked mechanically up to the practical limits of "fulling" and then is often, but not always, pressed to render

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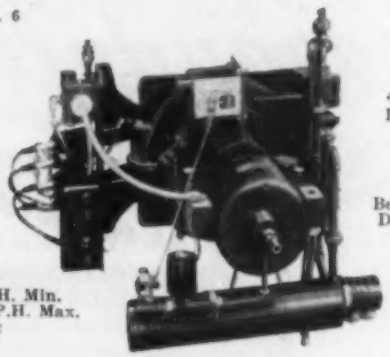

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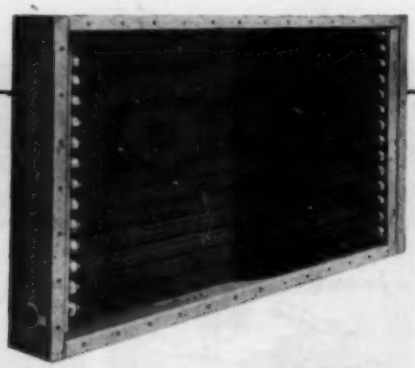

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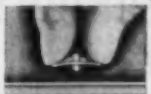
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Push down over stud with countersunk tool.

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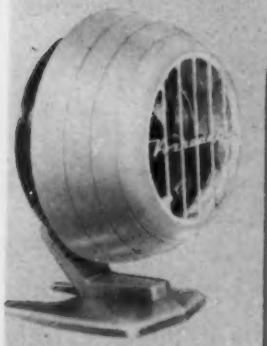

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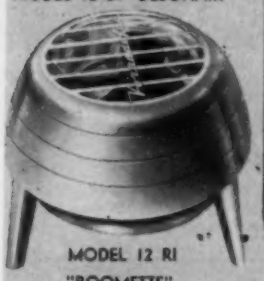

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it still more dense) are discussed by N. B. Pope in the March issue of Felt Facts, published by the Felt Association, Inc., 366 Madison Ave., New York 17, N.Y.

### Steam Traps

No. 6201—Features of inverted bucket steam traps manufactured by the V. D. Anderson Co., 1949 W. 96th St., Cleveland 2, Ohio, are briefly described in a new 4 page pamphlet. A discussion of the relative advantages of this type of trap is given.

### Tube End Forming Machine

No. 6202—Vaill Engineering Co., 17 Brown St., Waterbury 89, Conn., has issued a 4 page booklet describing the company's "No. 6" double action, air operated bench press which is designed for beading, flaring, flanging, expanding, and reducing tubing from ⅜ to 1 in. in diameter.

### Welding Accessories

No. 6203—Electrode holders and ground clamps, together with connectors, lugs, and splicers for arc welding cable are described and illustrated in a new 12 page booklet issued by Tweco Products Co., Wichita 1, Kan.

*For your convenience in obtaining copies of these bulletins, see coupon on page 149. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.*


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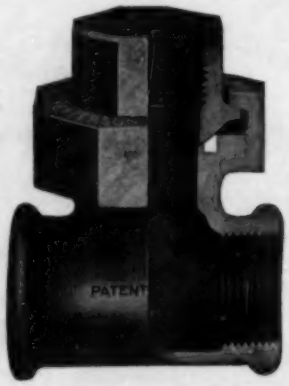

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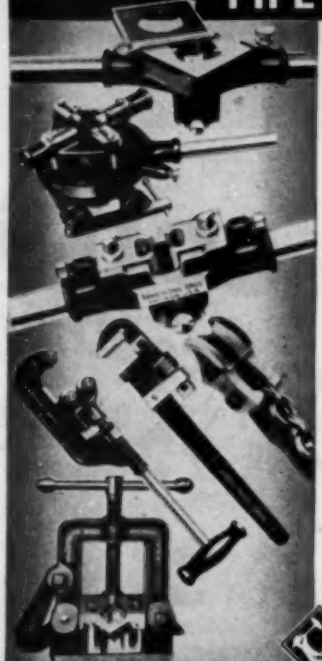

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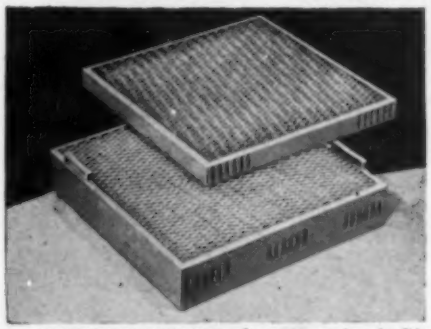

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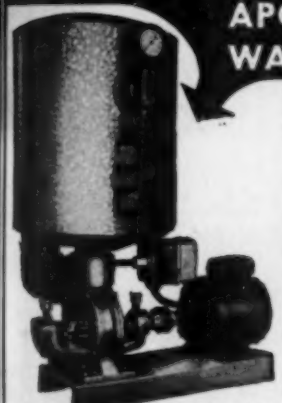

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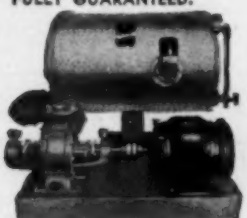

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## CPA Revises List of Critical Materials

The Civilian Production Administration has made public a revised list of critically scarce products, the producers of which may be granted urgency certificates to purchase surplus equipment from the War Assets Administration. These certificates described in Direction 16 to Priorities Regulation 13, give the holders precedence over any other class of buyers on WAA stocks of surplus equipment, and are granted only to producers of the products listed in Schedule 1 of PR-28, who can demonstrate that the equipment is urgently needed to sustain or increase their production.

All applications should be made on CPA Form 4425, which are available in the CPA Washington office, Washington 25, D. C., and in the 71 district construction offices, but when completed the forms must be filed only in the CPA Washington office.

Recent additions to the schedule of critical products include flat sheet specialized machinery, warm air furnaces, certain types of plumbing fixtures, large power presses, copper magnet wire, lead, and convector radiation (extended surface).

The schedule already included the following products: certain types of coal in specified areas, malleable and grey iron castings, including cast iron soil pipe, and cast iron radiation, lumber, concrete building products, titanium dioxide, rosin, fractional horsepower a-c motors, and electrical high-silicon sheet steel.

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